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President for Session 1920-21.

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SACTIONS

OF

THE CERAMIC SOCIETY

INCLUDING

THE REFRACTORY MATERIALS SECTION.

Founded in 1900 as "The North Staffordshire Ceramic Society," and continued from 1903 to 1916 as "The English Ceramic Society."

VOLUME XX.—SESSION 1920-21.

Authors are alone responsible for the Opinions expressed in their papers.

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CONTENTS.

PAGE.

I.—Introduction to Symposium on Art.. 1

G. M. Forsyth. Art in the Pottery Industry 2

H. J. Plant. Pottery Design from the Manufacturers' Point of View 8

J. W. Mellor. A Plea for Toleration in Art 11

II.—E. W. Smith. Introduction to Symposium on Gas Firing .. 20

III.—Ashley Myott. Presidential Address. Some Unsolved Problems in Pottery 39

IV.—A. S. W. Odelberg. Further Recent Improvements in Swedish Potteries 47

V.—Question Box I. 56

VI.—W. Lindley. A Recent Visit to some Spanish and Portuguese Potteries 72

VII.—A. B. Taylor and E. Irvine. On the Porosity, Strength and Absorbing Power of Certain Calcium Sulphate Cements 83

VIII.—B. J. Moore. Some Notes on Saggars 93

IX.—Question Box II. 105

X.—B. Moore. An Elutriation Test for Potters 112

XI.—J. W. Mellor. A Note on Thorpe's Solubility Ratio .. 120

XII.—A. Heath and A. Leese, The Effect of Calcination of Flints on Earthenware Bodies 121

Société de Chimie Industrielle, Paris. Annual Congress and Exhibition 127

Publications Received 127

List of Officers .. .. IV.

Rules .. .. VI.

List of Members .. .. VIII.

Proceedings .. .. XXIV.

Index of Transactions 128

Abstracts 1

Index of Abstracts 131

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RULES.

(Subject to modification by recommendations from the Refractory Materials Section).

1.—The Society shall be called THE CERAMIC SOCIETY. It shall comprise a special section dealing with Refractory Materials.

2.—The object of the Society shall be the discussion of all subjects relating to the industries connected with Clay Working and Refractory Materials.

3.—Persons desirous of membership shall be proposed and seconded by two Members of the General Meeting, and they are then eligible for election at the next Committee Meeting.

4.—The Society shall be governed by a President, Vice-Presidents and Council, a Librarian, a Secretary, and a Treasurer. The Officers shall be elected at the last General Meeting of each Session, and hold office until the last General Meeting of the ensuing Session, when they shall be eligible for re-election. Among the Vice-Presidents shall be included all past Presidents who are subscribing members of the Society. A Chairman of Council shall be appointed by the Committee.

4a.—The Council shall consist of officers, Ex-Presidents, and twelve members, of whom four shall resign each year, the retiring members to be eligible for re-election.

4b.—Two additional members of the Council, one of whom will also act on the Publication Committee, shall be elected by the Federation of Pottery Manufacturers.

5.—The headquarters of the Society shall be the Central School of Science and Technology, Stoke-on-Trent.

6.—The Meetings shall be fixed from time to time as arranged by the Sectional Committees. At Stoke-on-Trent the Meetings during the Session are usually held at 7-30 p.m. on the second Monday of the month.

7.—The annual subscription shall be payable in advance, and shall be fixed from time to time by the Committee (25/- for 1920-21). Members of the Society who have paid their annual subscription receive a copy of the TRANSACTIONS free.

8.—A firm can join the Society by paying an annual subscription of two guineas. For this subscription the attendance at each meeting shall be limited to three members of the firm, and one copy of the TRANSACTIONS will be supplied free annually.

9.—New members shall pay an entrance fee of one guinea.

10.—Students may be elected to Student Memberships without paying an entrance fee. Their subscription shall be 5/-, and will entitle them to attend the meetings, but no TRANSACTIONS will be supplied. After twelve months membership, a Student can be elected to full membership without payment of entrance fee. The Council shall decide whether a person is eligible for a Student Membership.

11.—Notification of meetings shall be sent by post to each member in Great Britain with the name of the subject of the paper for discussion.

12.—In the discussions arising upon any paper, no speaker shall occupy more than ten minutes, or make more than one speech, except by the permission of the Chairman.

13.—Any property of the Society lent to members must be returned within a week.

14.—Any member promising a paper and failing to keep his appointment shall himself provide a substitute.

15.—The Society shall have the prior right of publication of all papers read before it for a period of three months.

RULES—*Continued.*

16.—Authors must send their papers to the Society before or immediately after the communication has been read. If received in time the paper may be printed in time for the meeting. The official receipt of any paper will be dated from the time it is received by the Secretary.

17.—Members may obtain one copy of each of the back numbers of the TRANSACTIONS at subscription rates, providing they are for their own personal use, and that the number in stock be over 18.

18.—Members who are three years in arrear with their subscriptions shall be informed by means of a printed notice, and if the arrears are not paid within a month their names shall be struck off the list. *New Members are put on the list of members when their subscriptions have been paid.*

19.—A member of the Society may introduce a visitor to an ordinary meeting. A visitors' book is kept to show what non-members are present, and by whom they are introduced. The names of the visitors are read out by the Chairman at the opening of the same meeting.

20.—No alteration or addition to the above Rules shall be made except notice be given in General Meeting, and passed by the ensuing General Meeting. Ten to form a quorum.

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DRESSLER TUNNEL OVENS, Ltd., Argyle Works, Carter's Crossing, Fenton .. .. (1916-17)
DRESSLER, PHILIP, 1551, East Boulevard, Cleveland, Ohio, U.S.A. .. .. (1918-19)
DUNN, J. T., D.Sc., F.I.C., Public Analysts' Laboratory, 10, Dean Street, Newcastle-on-Tyne .. .. .. (1916-17)
EARDLEY, DONALD, The Avenue, Meir .. .. .. (1920-21)
EDWARDS, A. O., c/o The Yorkshire Refractories Co., Ltd., 27, Waterdale, Doncaster .. .. (1917-18)
EDWARDS C., 181, Terrace North, Fenton, Stoke-on-Trent.. (1914-15)
EGLINTON SILICA BRICK Co., Ltd., 45, Renfield St., Glasgow .. .. (1917-18)
ELLAND FIRECLAY Co., Ltd., Calder Fireclay Works, Elland (1916-17)
ELLIS, THOS., Penwyllt, near Neath .. .. (1916-17)
ELEY, ERNEST E., 15, Lord Street, Basford, Stoke-on-Trent (1920-21)
*EMERY, W., 7, Catherine Street, May Bank, Staffs. .. .. (1902-03)
ENDELL, K. Dr., Berlin Steglitz, Breitestrasse 3, Germany.. (1920-21)
ETCHELLS, H., 163, Oakbrook Road, Sheffield .. .. (1917-18)
EVERITT, CHARLES KINGSTON, c/o Edgar Allen & Co., Ltd., Imperial Steel Works, Sheffield .. .. .. (1916-17)
FAGAN, J. W., The Derbyshire Silica Fireclay Co., Hartington, near Buxton .. .. (1916-17)
FAILL, JAMES, Heathfield Fireclay Co., Ltd., 52, Robertson Street, Glasgow .. .. (1916-17)
FARNLEY IRON Co., Ltd., Farnley, near Leeds .. .. (1916-17)
FEARNSIDES, W. G., 10, Silver Birch Avenue, Fulwood, Sheffield.. .. .. (1916-17)
FERN, E. R., School of Art, Bombay .. .. (1906-07)
*FIELDING, A., Devon Pottery, Stoke-on-Trent .. .. (1902-03)
FIELDING, R., Devon Pottery, Stoke-on-Trent .. .. (1906-07)
FINN, R., 2, Eaton Street, Hanley .. .. (1920-21)
FLETCHER, C. G., Highbury, Chadfield Road, Duffield, near Derby .. .. (1917-18)
FOLEY, F. D., Loch Lomond Road, St. John's, N.B., Canada (1917-18)
FORSTER, A. LINDSAY, c/o Messrs. Chance Bros. & Co., Ltd., Glasgow, N.W. District Office .. .. .. (1916-17)
FOSTER, HENRY & Co. Ltd,, Backworth, Newcastle-on-Tyne (1916-17)
*FOSTER, J. E., 48, Gilman Street, Hanley .. .. .. (1909-10)
*FOX, W. G., 44, Riseley Road, Hartshill, Stoke-on-Trent .. (1912-13)
FOXWELL, G. E., 70, Steade Road, Sharrow, Sheffield .. (1916-17)
FRANCEY, D. M., 46, Woodgrange Avenue, North Finchley, London .. .. (1918-19)
FRANKLIN INSTITUTE, The, 13/17, South 7th Street, Philadelphia .. .. (1920-21)
FREEMAN, Dr. LUDFORD, Abbotsthorpe, Carnarvon Road, Redland, Bristol .. .. (1914-15)
FUJU, Y., c/o Japan Steel Works, Muroran, Hokkaido, Japan (1918-19)
FULPER, W. H., c/o The Fulper Pottery Co., Flemington, N.J., U.S.A. .. .. (1910-11)

GARDNER, W. J., c/o The Meltham Silica Brick Co., Ltd., Meltham, near Huddersfield.. .. .. (1916-17)
GARDNER, W. T., F.C.S., 14, Beechwood Avenue, Kew Gardens, London S.W. .. .. (1918-19)
GARLAND, C. S., 103, Cannon Street, London, E.C. 4 .. (1917-18)
GATENSBURY, H. R., Atlas Foundry, Victoria Road, Hanley (1913-14)
GIBBONS, Ltd., Dibdale Works, Dudley .. .. .. (1916-17)
GIBSON, H. M., c/o The A. Y. Dinas Silica Brick Co., Ltd., 37, Lady Street, Kidwelly, S. Wales .. .. .. (1916-17)
GIBBS, A. E., 1006, Widner Buildings, Philadelphia, Pa., U.S.A. .. .. (1918-19)
GIBSON, J., The Laboratory, Glengarnock Works, Glengarnock (1917-18)
GIBSON, J. M., Buckley, near Chester .. .. (1917-18)
GIBSON, R. M., Buckley, near Chester .. .. (1908-09)
GIBSON, W. F., c/o Turner Bros., Asbestos Co., Rochdale .. (1909-10)
GILBERT, WM., 31, Criffel Avenue, Streatham Hill, London, S.W. .. .. (1917-18)
GILBERTSON, W., & Co., Ltd., Portardawe Bridge Iron Works, Shotton .. .. (1916-17)
GILL, W. R., Cleveland Villa, Castleford, Yorkshire.. .. (1909-10)
GIMSON, J. F., 69, Fountain Square, Fenton, Stoke-on-Trent (1920-21)
GIPP, H. W., c/o Electrolytic Zinc Co. of Australia, Risdon Road, Hobert, Tasmania .. .. (1918-19)
GLASS RESEARCH ASSOCIATION, The, 50, Bedford Square, London, W.C. 1. .. .. (1920-21)
GLENBOIG UNION FIRECLAY Co., Ltd., Glenboig, Scotland (1916-17)
GLEAVES, E., Alsager House, Marsh Avenue, Wolstanton, Stoke-on-Trent .. .. (1920-21)
GLOVER, SAMUEL, F.R.M.S., Olive Mount, St. Anns, St. Helens .. .. (1916-17)
GODDARD, J. V., Trentham .. .. (1905-06)
GODDARD, A. H., c/o Messrs. G. L. Ashworth Bros., Ltd., Hanley .. .. (1918-19)
GOODWIN, F. T. H., Hollydean, Park Avenue, Longton .. (1910-11)
GODWIN, A. F., c/o J. Bourne & Son, Denby Pottery, Derby.. (1915-16)
GOODWIN, W. E., Watcombe House, 225, Waterloo Road, Burslem .. .. (1902-03)
GOODWIN, JOHN, Foley Works, Fenton, Stoke-on-Trent .. (1920-21)
GOSLING, JAS., Atlas Foundry, Victoria Road, Hanley .. (1913-14)
GOSS, W. H., Falcon Pottery, Stoke .. .. (1914-15)
GRAHAM, J. W., Ashley Villa, Lancaster Av., Newcastle Staffs. .. .. (1914-15)
GRAY, A. E., Glebe Works, Mayer Street, Hanley .. .. (1917-18)
GRAYSON, LOWOOD, J. & Co., Ltd., Deepcar, near Sheffield (1916-17)
GRAY, J., Auldhaven, Milngavie .. .. (1918-19)
GREAVES-WALKER, A. F., Box 1122, Pittsburgh, Pa, U.S.A. .. .. (1920-21)
GREEN, A. T., 24, Blurton Road, Fenton, Stoke-on-Trent .. (1917-18)
GREEN, J. C., Holme Cottage, Ford Houses, Wolverhampton (1911-12)
*GREEN, S. A., 23, Grove Road, Fenton, Staffs. .. .. (1905-06)
GREGORY, C., Newfield, Willington, Co. Durham .. .. (1916-17)
GREGORY, HAROLD, West View, Basford Park, Stoke-on-Trent (1913-14)
GREGORY, REDDISH & Co., Ltd., Silica & Firebrick Works, Deepcar, near Sheffield .. .. (1916-17)
GREGORY, T. W. D., Kinross, Trentham, Stoke-on-Trent .. (1906-07)
GRICE, E., 21, Station Road, Meir, Longton, Staffs. .. .. (1913-14)
GRIMWADE, C. D., Watlands, Wolstanton .. .. .. (1918-19)
GRIMWADE, L. L., Ashley, near Market Drayton .. .. (1906-07)
GRINDLEY, W. H., Woodland Pottery, Tunstall .. .. (1906-07)
GRIFFITHS, F. G., Quarter Denny, Stirlingshire .. .. (1918-19)
GROCOTT, F. J., 75, Shenstone Street, Edgbaston, Birmingham .. .. (1917-18)

GROCOTT, W., 75, Shenstone Road, Edgbaston, Birmingham (1918-19)
HADFIELD, SIR ROBERT, F.R.S., D.Met., D.Sc., 22, Carlton House, Terrace, London, S.W. .. .. .. (1916-17)
HARDY, C. H., c/o, Messrs. Reckitt & Sons, Hull .. .. (1918-19)
HALL, HY., The Bungalow, Botteslow, Hanley.. .. .. (1912-13)
HALL, J. & Co., Stourbridge .. .. (1916-17)
HAMILTON, J., Ideal Pottery, Trenton Potteries Co., Trenton, U.S.A. .. .. (1906-07)
HAMILTON, J. D., c/o R. Muir & Co., Ltd., Armadale Station Linlithgowshire .. .. (1917-18)
HAMILTON, WILLIAM, 93, West George Street, Glasgow .. (1917-18)
HAMMOND, PERCY, Newbridge House, Bollington, Macclesfield .. .. (1916-17)
HAMMOND, WILLIAM, Jevington, Bollington, Macclesfield (1916-17)
HAMPTON, T. E., Eastwood Marl Works, Hanley .. .. (1908-09)
HANCOCK, E. A., Kepax, Worcester .. .. (1916-17)
HANCOCK, F., Ford Street, Shelton, Stoke-on-Trent.. .. (1902-03)
HANCOCK, W. C., B.A., F.I.C., 60, Greek Street, Soho Square, London, W.1 .. .. (1917-18)
HARBORD, F. W., 16, Victoria Street, London, S.W. .. (1916-17)
HARRISON, A. C. Bath Street, Hanley .. .. .. (1910-11)
HARRIMAN, WM., & Co., Ltd., 51 Westgate Road, Newcastle-on-Tyne .. .. (1917-18)
HARRINGTON, T. H., 55, Stanley Street, Tunstall .. .. (1913-14)
HARTLEY, E., 41, Llanthewy Road, Newport, Mon... .. (1917-18)
HARTLEY, H. L., Castleford Pottery, Castleford, Yorks .. (1917-18)
HASSALL, W., Tresco House, Woodville, Burton-on-Trent (1920-21)
HAWTHORN, S., Mona House, Congleton, Cheshire.. .. (1905-06)
HAWTHORN, H., Morfa, Woodland Avenue, Wolstanton .. (1910-11)
HAWLEY, E., Woodland Cottage, Blurton, Staffs. .. .. (1914-15)
HAWLEY, ERNEST, c/o Messrs. Hawley & Jackson, Longton (1913-14)
HAWLEY, W. S., Fairmont, Sunny Bank Road, Newcastle, Staffs. .. .. (1908-09)
*HEATH, A., 61, Bethesda Street, Hanley .. .. .. (1900-01)
HEATH, C. H., High Street, Woodville, near Burton-on-Trent (1915-16)
HEATON, J., Ravenhead, St. Helens .. .. (1916-17)
HEATON, WM., Ravenhead Brick Co., Upholland, near Wigan (1917-18)
HENDERSON, H. B., 1538, N. High St., Columbus, Ohio, U.S.A. .. .. (1911-12)
HENDERSON, J. D., c/o The Anglo-Greek Magnesite Co., 24, Finsbury Street, London, E.C. .. .. (1917-18)
HEPWORTH IRON Co., Ltd., Hazlehead, near Sheffield .. (1916-17)
HERMANN, D. Rainhill, Lancashire .. .. (1918-19)
HEWITT, A. E., Easedale, Trentham, Stoke-on-Trent .. (1912-13)
HEWITT, F. G., 6, Boughey Street, Stoke-on-Trent .. .. (1918-19)
HEWSON, GEO. W., Grasmere, Field Terrace, Jarrow-on-Tyne (1917-18)
HICKMAN, H. T., Fireclay Works, Stourbridge .. .. (1916-17)
HIGGINS, F. W., Carborundum Co., Ltd., Trafford Park, Manchester .. .. (1918-19)
HILL, F. W., c/o Reliance Firebrick Pottery Co., Chanch, P.O. Baraker, E.I.R., Bengal, India .. .. .. (1917-18)
HILL, WESTLAKE & Co., Ltd., 8 Gloucester Sq., Southampton (1920-21)
HIMLEY FIRE & RED BRICK Co., Ltd., near Dudley .. (1916-17)
HINCHLIFFE, HERBERT, Bullhouse Colliery, Penistone, Sheffield .. .. (1917-18)
HIND, S. R., c/o Howsons, Hanley, Stoke-on-Trent .. .. (1918-19)
HOBBS, W. E., Dyserth, Flintshire .. .. (1916-17)
HODGKINSON, G., 19, Prince's Street, Tunstall .. .. (1918-19)
HODSON, G. A., c/o The Hathern Station Brick & Terra-Cotta Co., Ltd., Loughborough .. .. (1908-09)

HOLGATE, A., Bunyip, Victoria, Australia .. .. .. (1918-19)
*HOLDCROFT, A. D., Bradwell Lane, Wolstanton .. .. (1902-03)
*HOLDCROFT, J. P., Bradwell Lane, Wolstanton .. .. (1902-03)
HOLLINSHEAD, T., The Elms, Penkhull, Stoke-on-Trent .. (1906-07)
HOLLOWAY, L. J., c/o. No. 11, High Lane, Burslem, Stoke-on-Trent .. .. (1920-21)
HOPE, H., Fingringhoe, Colchester .. .. (1907-09)
HORSLEY, G., The Lawn, Belper .. .. (1908-09)
HOPE, G. W., The Dingle, Fingringhoe, Colchester .. .. (1920-21)
HOWE, J. ALLEN, Museum of Practical Geology, Jermyn Street, London, S.W... .. .. (1916-17)
HOWELL, C. G., 90, Leonard Road, Birches Head, Hanley .. (1916-17)
HOWELL, W. E., 41, Sneyd Terrace, Burslem .. .. .. (1915-16)
HOWLETT, S. & J., 23, Broom Street, Hanley .. .. (1918-19)
HOWIE, F. C., Hurlford, Fireclay Works, Kilmarnock .. (1916-17)
HOWSON, R. G., c/o Messrs. G. Howson & Sons, Limited, Hanley .. .. (1907-08)
HUGHES, F. S., Opal China Works, Fenton, Staffs. .. .. (1909-10)
HUNTBACH, J. J., 22, Louise Street, Burslem.. .. .. (1917-18)
HURLL, Ltd., P. & M., 144, West Regent Street, Glasgow .. (1917-18)
HUTCHESON, R. E. B., The A. Y. Dinas Silica Brick Co., Ltd., Holloway Villa, Kidwelly, S.W. .. .. (1916-17)
HUTCHINSON, A., M.A., B.Sc., Manestry, Saltburn-by-the-Sea, Yorks. .. .. (1916-17)
HUTTON, R. S., D.Sc., Dam House, Mushroom Lane, Sheffield (1916-17)

JACKSON, G. J., Thanet House, Strand, W.C.2 .. .. (1917-18)
JACOBSEN, CARL, Malmogade 7, Copenhagen, Denmark
JACKSON, E. W., F.I.C., Godrevy, Saltburn-by-the-Sea .. (1918-19)
JEFFREY, Dr. J. A., c/o Jeffery-Dewitt Co., Detroit, Mitch,, Mich., U.S.A. .. .. (1917-18
JENKINSON, W., The Edinburgh & Leith Flint Glass Co., Edinburgh .. .. (1916-17)
JEPPSON, G. N., 41, Burncoat Street, Worcester, Mass., U.S.A. .. .. (1912-13)
JOHNSON, A. S., c/o Messrs. Alfred Meakin, Ltd., Tunstall.. (1909-10)
JOHNSON, S. Ltd., Brittania Pottery, Burslem, Stoke-on-Trent .. .. (1920-21)
JOHNSTONE, T. B., Park House, Eastfield Park, Weston-Super-Mare .. .. (1918-19)
JOHNSON, J., 51, Dunrobin Street, Longton .. .. .. (1918-19)
JOHNSON, E., c/o Messrs. W. Boulton, Ltd., Navigation Rd., Burslem .. .. (1909-10)
JOHNSON, H., Tile Manufacturer, Highgate Tile Works, Tunstall .. .. (1906-07)
JOHNSON, J., Talke and Alsager Road, Alsager .. .. (1912-13)
JOHNSON, R. L., Oulton Rocks, Stone, Staffs... .. .. (1912-13)
JOHNSON, W. P., B.Sc., 28, High Street, Wallheath, near Dudley .. .. (1910-11)
JOHNS, C., 404, Pitsmoor Road, Sheffield .. .. .. (1917-18)
JONES, A. B., Junr., Grafton Works, Longton .. .. .. (1914-15)
JONES, A. G., Lynton, Trentham, Staffs. .. .. .. (1909-10)
JONES, A. G. H., Heath House, Uttoxeter .. .. .. (1905-06)
JONES, CHARLES, Heatherfield, Bwlchgwyn, near Wrexham (1916-17)
JONES, E. A., Glendene, Stallington Road, Blythe Bridge .. (1903-04)
JONES, F., Afanlea, Stone Road Longton .. .. .. (1908-09)
JONES, L., Southwood, c/o Messrs. Southwood, Jones & Co., Danycraig Works, Risca, Monmouth .. .. .. (1916-17)
JONES, N. L., c/o J. & G. Meakin, Ltd., Hanley .. .. (1914-15)
*JONES, R. H. H., Riversdale, Keyberry Road, Newton Abbot (1900-01)
JONES, Sir W. J., Woodhall-Duckham and Jones, 52, Grosvenor Gardens, Westminster, S.W.,1 .. .. .. (1916-17)

KEELING, F. A., c/o Messrs. Keeling & Walker, Stoke-on-Trent .. .. (1906-07)
KEELING, J., c/o Keeling & Co., Dalehall, Burslem .. .. (1906-07)
KEELING, G. A., Brown Edge Road, Stockton Brook, Stoke-on-Trent .. .. (1918-19)
KENT, H., 4, The Croft, Tenby .. .. (1918-19)
KENT, D. F., 72, Leonard Street, Burslem .. .. .. (1903-04)
KENT, W., c/o. Messrs. Taylor Tunnicliff & Co., Hanley, Stoke-on-Trent .. .. (1920-21)
KILNER, N. S., Hepworth Chambers, Briggate, Leeds.. .. (1918-19)
KING, C. A. .. .. (1917-18)
KIRKLAND, H. S., Albion Pottery, Etruria, Stoke-on-Trent (1906-07)
KLEIN, CARL, A., 4, Brimsdown Av., Enfield Highway, Middlesex .. .. (1915-16)
KNIGHT, W. C., 29, Rushton Road, Cobridge, Burslem .. (1908-09)
KREHBIEL, J. F., 168E, Gateview Avenue, Columbus, Ohio, U.S.A. .. .. (1917-18)

LAMPLOUGH, F. E., M.A., c/o Messrs. Chance Bros. & Co., Ltd., Glass Works, near Birmingham .. .. .. (1918-19)
LANCASTER, E., Lyndhurst, Trentham .. .. .. (1914-15)
LAX, F., Albert Glass Works, Hunslet, Leeds .. .. .. (1917-18)
LEACH, C. A., Padeswood, Weston Coyney, Stoke-on-Trent.. (1912-13)
LEATHER, J. P., Gas Works, Burnley .. .. (1916-17)
LEE, L. W., c/o Farmer & Chapman, Caledonian Works, Bilston (1918-19)
LEEDS FIRECLAY Co., Ltd., Wortley, Leeds.. .. .. (1916-17)
*LEESE, A., 81, Vivian Road, Fenton, Staffs. .. .. .. (1900-01)
LEIGH, A. K., Cranbourne, Oulton Cross, Stone, Staffs. .. (1914-15)
LEIGHS, T. J., 20, Clarke Street, Shelton, Stoke-on-Trent .. (1920-21)
LESSING, R., PhD., The Laboratory, Southampton House, 317 High Holborn, London .. .. (1910-11)
LEWIS, E. H., Waygateshaw, Carluke, Scotland .. .. (1917-18)
LILLESHALL (The) Co., Ltd., Priors Lee Hall, Shifnal, Salop (1916-17)
LILLIBRIDGE, H. D., c/o American Encaustic Tiling Co., Ltd. Zanesville, Ohio, U.S.A. .. .. (1916-17)
LINDOP, R. C., 41, Grove Road, Fenton.. .. .. .. (1913-14)
LINBARGER, S. C., c/o The Carborundum Co., Niagara Falls, N.Y., U.S.A. .. .. (1918-19)
LINSTRUM, T., 2, Oakwood Drive, Roundhay, Leeds.. .. (1917-18)
LLOYD, HORACE, Messrs. N. B. Allen & Co., Ltd., Hirwain, South Wales .. .. (1917-18)
LLOYD, W. J., Rothesay, King's Avenue, Wolstanton .. (1915-16)
LLOYD, T. H., c/o The Pure Bone Phosphate Co., 27, Kirkgate, Newark .. .. (1918-19)
LOCKHART, D. B., Victoria Pottery, Pollokshaws, Glasgow (1918-19)
LOMAX, J. R., 327, Bury Road, Bolton.. .. .. .. (1917-18)
LOUDON, JOHN, Loudon & Russell, Ltd., Allanton Fireclay Works, Newmains, Scotland.. .. .. (1917-18)
LOVATT, L. D., 79, Festing Street, Hanley .. .. .. (1916-17)
LOXTON, N. G., Leeds Fireclay Co., Burmantofts Works, Leeds .. .. (1918-19)
LYSAGHT, J., Ltd., Normanby Park Works, Scunthorpe, Lincs. (1918-19)

MACFARLANE, A. & P., 121, St. Vincent Street, Glasgow (1917-18)
MACHIN, C. W., 65, Trentham Road, Longton.. .. .. (1914-15)
MACLAY, DAVID M., Dalzell Steel and Iron Works, Motherwell .. .. (1917-18)
MacNEAL, C., Highfield House, Fenton, Staffs. .. .. (1910-11)
MacWHIRTER, J., Elisnore, Milngavie, Scotland .. .. (1917-18)
McCORMICK, J., Dock Office, Hull, Yorks. .. .. .. (1917-18)
McDONALD, J. A. K., 24, Chapel Street, Liverpool .. .. (1916-17)
MALINOVSZKY, A., 22, N. Douglas Avenue, Belleville, Ill., U.S.A. .. .. (1916-17)

MALKIN, S., c/o The Malkin Tile Works Co., Burslem .. (1905-06)
MALKIN, W. F., Dalehall Mill, Burslem .. .. .. (1914-15)
MALKIN, J. R., The Limes, Porthill, Longport .. .. (1918-19)
MANCHESTER FURNACES Ltd., Ashton New Road, Manchester .. .. (1920-21)
MANSFIELD, F., Red Cross Street, Liverpool .. .. .. (1918-19)
MARLOW, J. H., 19, Villas, Stoke-on-Trent .. .. .. (1916-17)
MARSHALL, F. G., 56, Berwick Road, Gateshead .. .. (1911-12)
MARSHALL, F. J., 25, Marine Parade, Sheerness-on-Sea, Kent (1920-21)
MASON, ADAM & SONS, Ltd., Horwich, Lancashire.. .. (1916-17)
MAURITZEN, C. F., Calyx Paint Works, Lord Street, Perth, Western Australia .. .. (1920-21)
MAYER, E., Beaver Falls, Pa, U.S.A. .. .. (1904-05)
*MAYER, E. W. T., 11, Westwood Road, Wolstanton.. .. (1914-15)
MEADE, ALWYNE, Commercial Gas Co., Wapping, London, E. 1 .. .. (1916-17)
MEAKIN, J. & G., Ltd., Eagle Pottery, Hanley, Stoke-on-Trent .. .. (1918-19)
MEAKIN, J. & G., Ltd., Eastwood Works, Hanley, Stoke-on-Trent .. .. (1918-19)
MEIR, J., 240, Waterloo Road, Burslem.. .. .. .. (1911-12)
MEIGH, N., 90, Peel Street, Dresden, Longton .. .. (1920-21)
MELLOR, J. R., Eversley Villa, Ricardo St., Dresden, Longton (1910-11)
*MELLOR, J. W., D.Sc., Sandon House, Regent St., Stoke-on-Trent .. .. (1904-05)
METCALFE, E. D., c/o Curtiss & Harvey, Ltd., 110, Cannon Street, London, E.C. 4 .. .. (1918-19)
MEREDITH, J., 42, Stanley Street, Tunstall .. .. .. (1911-12)
MEREDITH, L. Clenard, Blythe Bridge, Stoke-on-Trent .. (1918-19)
McCANCE, Dr. A., 63, Lauderdale Gardens, Glasgow.. .. (1918-19)
McDOWELL, J. S., 1800, Farmers Bank Buildings, Pittsburgh, U.S.A. .. .. (1918-19)
MICHIE, A. C., 82, Collingwood Building, Newcastle-on-Tyne (1910-11)
MIDDLETON FIRECLAY WORKS, Leeds .. .. .. (1916-17)
MITCHELL, JOHN, c/o A. Y. Dinas Silica Brick Co., Ltd., 142, Queen Street, Glasgow .. .. (1916-17)
MITCHELL, J. S., Hyland, Hargate Drive, Hale, Manchester (1917-18)
*MOORE, B., Draycott, Blythe Bridge, Stoke-on-Trent .. (1900-01)
MOORE, BERNARD, J., c/o Messrs. Josiah Wedgwood & Sons, Etruria .. .. (1913-14)
MOORE, C. H., 244, Fulwood Road, Sheffield .. .. (1917-18)
MOORE, HOWARD, c/o Harper & Moores, Ltd., Stourbridge (1916-17)
MOSS, G. H., 47, Heron Street, Fenton, Stoke-on-Trent .. (1920-21)
MOMOKI, S., 33, Kobayashi-Cho, Nagoya, Japan .. .. (1916-17)
MONTGOMERY, ROBERT J., c/o Bausch & Lomb Optical Co., Co., Rochester, N.Y., U.S.A .. .. (1918-19)
MONTGOMERY, ALLAN W., 58, York Street, Glasgow .. (1918-19)
MORTON, JOSEPH, Ltd., Cinder Hill Fireclay Works, Halifax, Yorks. .. .. (1917-18)
MORRALL, F., 49, Kensington Road, Oakhill, Stoke-on-Trent (1917-18)
MOTTRAM, GEO. WM., 161, New Bond Street, London, W. 1 (1916-17)
MOULTON, D. A., Mexico, Mincuri, U.S.A. .. .. .. (1918-19)
MYOTT, A., c/o Messrs. Myott, Son & Co., Cobridge, Burslem (1904-05)

NEGUS, W., 36, Bloomsbury Square, London, W.C. 1 .. (1918-19)
NEILL, G. W., 181, Main Street, Bellshill, Lanarkshire .. (1918-19)
NEWBY, F. B., c/o Malkin Tile Works, Burslem, Staffs .. (1917-18)
NEWMAN, H. S., Sunnyside, Oxford Road, Basford Park, Stoke-on-Trent .. .. (1917-18)
NICHOLSON, E. D., Park Issa, Oswestry .. .. .. (1918-19)
NICHOLAS, L. D. .. .. (1918-19)
NIXON, WM., Mayfield, Weston Coyney, Stoke-on-Trent .. (1916-17)
NOBLE, E., Birch House, Worksop .. .. (1917-18)

OATES & GREEN, Ltd., Halifax, Yorks. .. .. .. (1916-17)
OAKES, W. c/o. Sand, Glass & Foundry Materials (Amalgamated) Ltd., 27, Waterdale, Doncaster .. .. .. (1920-21)
*ODELBERG, A. S. W., Gustafsberg Pottery, Sweden .. .. (1904-05)
OKURA, K., 22, Ipponmattsu, Azab, Tokyo, Japan .. .. (1915-16)
*OLSEN, B., The Villas, Stockton Brook, Stoke-on-Trent .. (1900-01)
ORMANDY, W. R., D.Sc., Oakley House, Bloomsbury Street, London, W.C. 1 .. .. (1917-18)
ORTON. E., Columbus, Ohio, U.S.A. .. .. (1903-04)
OUGHTIBRIDGE SILICA FIREBRICK WORKS, The Oughtibridge, Sheffield .. .. (1916-17)
OWEN, T. WILFRED, 4, Dukes Place, St. Georges, Shropshire .. .. (1920-21)
OWENS, R. S., D.S.O., D.Sc., F.R.S.C., 15, South 7th St., Philadelphia, U.S.A. .. .. (1918-19)

*PAGE, E. P., 123, Abbey Foregate, Shrewsbury .. .. (1904-05)
PAINE, W. H. C., Calder Fireclay Co., Coatbridge .. .. (1916-17)
PAINE, J. W. R., Calder Fireclay Co., Coatbridge .. .. (1918-19)
PARKER, W. B., F.I.C., 1, Murrey Road, Rugby .. .. (1918-19)
PARKINSON & SPENCER, Ambler Thorn Fireclay Works, Halifax .. .. (1916-17)
PARMELEE, C. W., Professor of Ceramic Engineering, University of Illinois, Urbana, Illinois, U.S.A. .. .. (1906-07)
PARRY, ROBT., Oak Bank, Rhos., near Wrexham .. .. (1916-17)
PASS, R. H., West Rising, Onondaga Pottery Co., Syracuse, N.Y., U.S.A. .. .. (1920-21)
PEARSALL, W. H., c/o Mobberley & Bayley, Stourbridge .. (1916-17)
PEARSON, E. J. & J., Ltd., Fireclay Works, Stourbridge .. (1916-17)
PEARSON, JOHNSON, Fern House, Stonegravels, Chesterfield (1918-19)
PEARSON, JOHNSON, The Potteries, Whittington Moor, near Chesterfield .. .. (1918-19)
POUNTNEY & Co., Ltd., The Bristol Pottery, Fishponds, near Bristol .. .. (1918-19)
PEREGRINE, C. R., 5555, Forbes Street, Pittsburgh, Pennsylvania .. .. (1917-18)
PERRY, PEARSON G. H., Portland House, Pedmore, nr. Stourbridge .. .. (1916-17)
*PERRY, T., 247, Campbell Road, Stoke-on-Trent .. .. (1910-11)
PICKFORD, HOLLAND & Co., Ltd., Eclipse Ganister Works, Sheffield .. .. (1916-17)
PICKFORD, R. J., Thornlea, Carmel Road, Darlington .. (1917-18)
PIKE, L. G., Wareham, Dorset .. .. (1912-13)
PIMBLE, A. V., West Street, Penkhull, Stoke-on-Trent .. (1918-19)
PINHEIRO DA SILVA, ISRAEL CARTHE, Minas Gerais, Brazil, South America .. .. (1920-21)
PINKERTON, D. J., Dalzell Steel & Iron Works, Motherwell (1916-17)
PITCAIRN, G., Fabrica-de-Loza, San Juan de Aznal-farache, Sevilla, Spain .. .. (1916-17)
PLANT, F., Stone Road, Longton .. .. (1912-13)
*PLANT, H. J., Rostherne Park Avenue, Longton, Stoke-on-Trent .. .. (1902-03)
PLANT, J., Melbourne House, Stone .. .. (1912-13)
PODMORE, A. J., Tunstall Art Pottery, High Street, Tunstall (1916-17)
PODMORE, WM., Consall Hall, Consall, Stoke-on-Trent .. (1913-14)
POOLE, THOS., Cobden Works, Longton .. .. .. (1915-16)
POOLE, HORACE, 96, Chaplin Road, Longton .. .. (1916-17)
POWELL, W. H., 1170, Broadway, New York City, U.S.A... (1908-09)
PRESTON, D., 35, High Street, Bucknall, Stoke-on-Trent .. (1916-17)
PRICE, G., Clifton, Silverdale Road, Wolstanton, Staffs. .. (1908-09)
PRICE, J. T. & Co., Ltd., Stourbridge .. .. (1916-17)
PRICE, S. H., St. George's, Porthill, Longport, Stoke-on-Trent (1912-13)

PRYOR, E. A. COAD, The National Physical Laboratory, Teddington, Middlesex .. .. (1917-18)
PULLWOOD, W., Clattershall Hall Fireclay Works, Stourbridge .. .. (1917-18)

*RAMSDEN, C. E., Foley Colour Works, Fenton, Stoke-on-Trent (1902-03)
RAMSAY, A., Mount Savage, Md., U.S.A. .. .. .. (1908-09)
RANN, R. C., 14, Great George Street, Westminister, London, S.W. 1. .. .. (1918-19)
REDFERN & DRAKEFORD, Balmoral Works, Normacot, Stoke-on-Trent .. .. (1918-19)
RELIANCE FIREBRICK & POTTERY Co., Ltd., The (Andrew Yule, Agents), 8, Clive Row, Calcutta .. .. (1920-21)
REES, WALTER, J., Department of Refractory Materials, The University, Sheffield .. .. (1916-17)
RHEAD, F. H., Director, Research Dept., American Encaustic Tiling Co., Zanesville, Ohio, U.S.A. .. .. (1920-21)
REYNOLDS, G., Tachbroke House, Normacot.. .. .. (1903-04)
*RICHARDSON, A. G., "Linden," Oakville Avenue, High Lane, Burslem .. .. (1900-01)
RICHARDSON, GEO., 140, Pinnox Street, Tunstall .. .. (1913-14)
RICHARDSON, W. D., The Claycroft Mining and Brick Co., Shawnee, Ohio, U.S.A. .. .. (1906-07)
RIDGE, H. M., 2, Great Winchester Street, E.C. 2 .. .. (1917-18)
RIDGWAY, B. Bedford Works, Hanley .. .. (1913-14)
RIDOUT, ALFRED J., 162, Milcote Road, Smethwick .. (1917-18)
RIES, H., Cornell University, Ithaca, New York .. .. (1911-12)
RIGBY, A., 164, Trentham Road, Penkhull .. .. .. (1920 21)
RILEY, HAROLD E., Tresco, St., Austell .. .. .. (1917-18)
ROBERTS, J. G., c/o Messrs. Shanks & Co., Barrhead, N.B (1904-05)
ROBINSON, H. M., c/o Messrs. Minton & Co., Ltd., Stoke-on Trent .. .. (1909-10)
ROBINSON, H. T. .. .. (1917 18)
RODGER, P. WYLIE, 18, Charles Street, St. Rollox, Glasgow (1918-19)
ROGERS, T. H., c/o Heron, Rogers & Dehn, Broad Sanctuary Chambers, 11, Tothill Street, Westminster, S.W. 1 .. (1917-18)
ROSS, DONALD W., The Findlay Clay Pot Co., Washington, Pa, U.S.A. .. .. (1917-18)
RUSSELL, FRANK, Highland Grove, Worksop .. .. (1916-17)
RUIZ, F., c/o Banco de Chile, 94, Gracechurch Street, London (1918-19)

SADLER, EDWARD, Newlands, Watlands Avenue, Wolstanton (1917-18)
SAILLY, PAUL, Compagnie Générale d'Electro-Céramique, 64, Rue Franklin, Ivry-Port, Seine, France .. .. (1917-18)
SANDLAND, T. H., Whitebridge, Newcastle Road, Stone, Staffs. .. .. (1917-18)
SANITER, E. H., Phoenix Special Steel Works, The Ickles, Sheffield .. .. (1916-17)
SANKEY, C. H., Wildcroft, Chislehurst, Kent.. .. .. (1916-17)
SATCH SHINZO, TOKIO ELECTRIC Co., Ltd., Kawaski, Kanagawa-Ken, Japan .. .. (1920-21)
SAXTON, C., Les Verreries, Argues-Mortes (Gard), France .. (1918-19)
SAYER, JAMES, Junr., Hill Crest, James St., Stoke-on-Trent (1912-13)
SCHURECHT, H. G., 141, Pace Avenue, Columbus, Ohio, U.S.A. .. .. (1918-19)
SOCIETE DES PRODUITS CERAMIQUES ET REFRACTAIRES, 44, Rue Blanche, Paris,.. .. .. .. (1918-19)
SCRIVENER, E. D., c/o Messrs. Taylor, Tunnicliff & Co., Eastwood, Hanley .. .. (1908-09)
*SCOTT, A., M.A., D.Sc., Central School of Science and Technology, Stoke-on-Trent .. .. (1917-18)
*SEARLE, A. B., The White Building, Sheffield.. .. .. (1907-08)

*SHAH, C. P., Zarina Cottage, Sandhurst Road, Bombay .. (1913-14)
SHANKS, D., Arthurlie, Barrhead, N.B. .. .. .. (1905-06)
SHAW, A. G., Whitebrick Brick Works, Darwen, Lancs. .. (1918-19)
SHAW, W. & Co., Willington Foundry, Middlesborough .. (1918-19)
SEABRIDGE, F. S., 4, Market Square, Hanley, Stoke-on-Trent (1918-19)
SHELLEY, P., c/o Messrs. Wileman & Co., Foley China Works Longton .. .. (1905-06)
SHENTON, R., c/o Messrs. Wedgwood & Co., Tunstall .. (1903-04)
SHEPPARD, P. N. F., 2, The Avenue, Beckenham, Kent .. (1917-18)
SHERLOCK, A., Winterton Pottery, High Street, Longton .. (1916-17)
SHORTER, J. G., Chetwynd House, Wolstanton, Stoke-on-Trent (1909-10)
SILLARS, D., Bidston, Britannia Terrace, Saltburn by-the-Sea (1918-19)
SIMPSON, T. A., Lyndhurst, Wolstanton .. .. .. (1914-15)
SIMPSON, T. G., 34, Elm Street, Cobridge, Stoke-on-Trent.. (1917-18)
SIMPSON, W. A., 27, Kensington Road, Oakhill, Stoke-on-Trent .. .. (1916-17)
SIMPSON, E., Pynest Street, Hanley, Stoke-on-Trent .. (1918-19)
SINGH, K., 23a, Copeland Street, Stoke-on-Trent .. .. (1918-19)
SINGH DOGAR, c/o Manufacture National de Porcelain de Sévres, France .. .. (1918-19)
SITCH, CHARLES HENRY, Workers' Institute, Cradley Heath, Staffs. .. .. (1916-17)
SMART, H. E., Mountain View, Kidwelly, Carmarthenshire.. (1916-17)
SMITH, H. PROCTER, Hawarden Bridge Steel Works, Shotton, Chester.. .. .. (1916-17)
SMITH, OLIVER, Lilac House, Old Hunwick, nr. Willington, Co. Durham .. .. (1916-17)
SMITH, F.R., Eastfield, Ironbridge, R.S.O., Salop .. .. (1902-03)
SNEYD COLLIERIES, Ltd., Burslem .. .. (1916-17)
SNOW, Major N. R., c/o The Standard Bank of South Africa, Ltd., 68, Wall Street, New York City, U.S.A. .. .. (1918-19)
SNOW, W. R., Manor House, Wellington, Surrey .. .. (1918-19)
SOLON, L. V., c/o American Encaustic Tile Co., Ltd., 16, East 40th Street, New York, U.S.A. .. .. (1915-16)
SOMERVILLE, W., The Cottage, Hindlow, Buxton .. .. (1916-17)
SOSMAN, R. B., 2801, Upton Street, Washington, D.C. U.S.A. .. .. (1918-19)
SOUDIER, H., 174, et 176, Boulevard Saint-Germain, Paris.. (1918-19)
SOUTH METROPOLITAN GAS Co., 709, Old Kent Road, London, S.E. 15 .. .. (1917-18)
SPEIRS, C. W., The Morgan Crucible C., Battersea Works, London .. .. (1916-17)
STAFFS. CROWN COLOUR Co., 5, Lord Street, Basford .. (1918-19)
STANLEY, C., 8, Stoke Road, Stoke-on-Trent.. .. .. (1920-21)
*STANLEY, WALTON, 8, Stoke Road, Shelton .. .. .. (1911-12)
STANYER, A., 24, Jenkins Street, Burslem .. .. .. (1903-04)
STATON, A. D., 37, King's Avenue, Wolstanton, Stoke-on-Trent .. .. (1920-21)
STEAD, J. E., 11, Queen's Terrace, Middlesbro' .. .. (1916-17)
STEELE, H. L., Regent Road, Hanley .. .. .. (1912-13)
STEIN, JOHN G. & Co., Ltd., Bonnybridge, Scotland .. (1916-17)
STEPHENS, ALFRED, Broomhill, Kidwelly .. .. .. (1916-17)
STEVENSON, H. W., Montrose, 1st Avenue, Porthill .. (1913-14)
STIFF, S. J., c/o Messrs. B. Fayle & Co., Ltd., Corfe Castle Dorset .. .. (1913-14)
STOTT, VAUGHAN H., 9, Elmers Drive, Teddington, Middlesex.. .. .. (1920-21)
SATOH, SHINZO, Tokyo Electric Co., Ltd., Kawasaki, Kanagawa-ken, Japan .. .. (1920-21)
STOURBRIDGE REFRACTORIES Co., Ltd., Pensnett, nr. Dudley .. .. (1916-17)
STOVER, E., 474, West State Street, Trenton, U.S.A. .. (1903-04)

STRINGER, G. E., Wynberg, Newcastle Road, Stone, Staffs. (1918-19)
STUBBS, R., Church Terrace, Blythe Bridge .. .. .. (1920-21)
SUTHERLAND, W. F., 37, Columbine Avenue, Toronto, Canada .. .. (1918-19)
SWINDEN, THOMAS, 26, Oak Hill Road, Nether Edge, Sheffield (1916-17)
SWINNERTONS, Ltd., Vulcan Pottery, Hanley, Stoke-on-Trent (1918-19)

TAMS, H., Wharf Street, Longton, Stoke-on-Trent .. .. (1913-14)
TATLER, W. J., Joiners Square, Hanley, Stoke-on-Trent .. (1918-19)
TAYLOR, A. B. (Miss), Dunstable House, Sheen Road, Richmond .. .. (1918-19)
TAYLOR, F. E., Trentham, Staffs. .. .. (1913-14)
TAYLOR, J. F., Trentham, Staffs. .. .. (1915-16)
TAYLOR, T. M., Shanklin, Weston Road, Meir .. .. (1908-09)
TEALE, JAMES W., 33, Grange Road, Brook Lane, Chester .. (1920-21)
THOMAS, C. W., c/o Messrs. E. J. & J. Pearson, Ltd., Brierley Hill, S. Staffs. .. .. (1903-04)
*THOMASON, W., Royal Doulton Potteries, Lambeth, London, S.E. .. .. (1909-10)
THORLEY, P. S., Froghall Lime Works, Cheadle, Staffs. .. (1907-08)
THORLEY, J. P., 31, Newcastle Road, Shelton, Stoke-on-Trent .. .. (1920-21)
THRELFALL, C. R. F., c/o Timmis & Co., Stourbridge .. (1920-21)
TILL, H. H., 28, West Parade, Mount Pleasant, Fenton .. (1911-12)
*TIMMIS, G. H., Storrage House, Wribbenhall, Bewdley .. (1916-17)
TOOGOOD, H. J., The Poplars, Elland, Yorkshire .. .. (1918-19)
TOOTH, W. E., Claridge House, Woodville, Burton-on-Trent (1913-14)
*TOWNSEND, H., Mount Avenue, Hartshill, Stoke-on-Trent (1909-10)
TRAVIS, W. P., Church Street Chambers, Stourbridge .. (1916-17)
*TURNER, F., 2, York Street, Burslem .. .. (1900-01)
TURNER, W. E. S., D.Sc., Department of Glass Technology, The University, Sheffield .. .. (1916-17)

UNITED COLLIERIES, Ltd., 109, Hope Street, Glasgow .. (1916-17)
UNITED ALKALI Co., Cunard Building, Liverpool .. .. (1917-18)
UNIVERSITY OF WASHINGTON LIBRARY, Seattle, Washington .. .. (1920-21)
UNIVERSITY OF CALIFORNIA LIBRARY, Berkley, California, U.S.A. .. .. (1920-21)

VAUGHAN, A. J., Grant Street Colour Works, Burslem .. (1914-15)
VICKERS, A. E. G., 27, Lily Street, Wolstanton, Stoke-on-Trent .. .. (1918-19)

WADE, G., High Street, Burslem .. .. (1914-15)
WALKER, E. E., The Australian Tesselated Tile Co., Ltd., Mitcham, Victoria Australia .. .. (1916-17)
WALKER, F. W., Art Tile Works, Beaver Falls, Pa, U.S.A. (1906-07)
WALKER, JOHN, The Gate Farm Fireclay & Firebrick Works, Kingswinford, near Dudley .. .. .. (1916-17)
WALKER EDWARD, M.Sc., F.G.S., Editor of the Mining Magazine, 724, Salisbury House, London, E.C. .. .. (1918-19)
WALLACE, J. C., 71, West Nile Street, Glasgow .. .. (1918-19)
WALLACE, Miss JANET A., B.Sc., Taylorbank, Union Street, Motherwell .. .. (1917-18)
WALMSLEY, J. H., "Inauda," Solihull, Birmingham .. (1902-03)
WALTON, C. J., Forsbrook, Stoke-on-Trent .. .. .. (1912-13)
WARBURTON, T. H., The Monk Bridge Iron & Steel Co., Ltd., Leeds .. .. (1916-17)
WARD, T. W., Endcliffe Vale House, Sheffield .. .. (1917-18)
WATERHOUSE, JAMES, Ltd., Soho Works, Wakefield .. (1916-17)
WATTISON, J. T. Rua da Restauraçaõ, 122, Porto, Portugal (1918-19)
WATKIN, E., 57, Yoxall Avenue, Hartshill .. .. .. (1916-17)
*WATKIN, H., Woodleigh, Porthill, Stoke-on-Trent .. .. (1900-01)

WATKIN, T., Harding Terrace, Sheppard St., Stoke-on-Trent (1904-05)
WATTS, A. S., Mines Building, O.S.U., Columbus, Ohio, U.S.A. (1910-11)
WEATHERBY, W. H., c/o C. Tenant & Sons & Co., Ltd., 80/82, Merchants Exchange, Cardiff.. .. .. .. (1918-19)
WEBSTER, J. C., Bridge Pass, Victoria Road, Tunstall .. (1910-11)
WEBSTER, JAS., 15, Peele Street, Tunstall .. .. .. (1913-14)
WEDGWOOD, Miss A., The Woodhouse, Cheadle, Staffs. .. (1916-17)
WEDGWOOD, ERNEST, B., The Grove, Wolstanton.. .. (1916-17)
*WEDGWOOD, F. H., c/o Josiah Wedgwood & Sons, Ltd., Etruria, Stoke-on-Trent .. .. (1905-06)
WELLINGTON GAS Co., Courtney Place, Wellington, N.Z.
WELLS, J. H., 10, Glanbrydan Avenue, Uplands, Swansea.. (1916-17)
WENGER, A. F., Victoria House, Newcastle, Staffs... .. (1905-06)
WENGER, A. H., Trentham Priory, Staffs. .. .. .. (1902-03)
WENGER, F. E., The Hollies, The Brampton, Newcastle Staffs (1905-06)
WERNER, E. A. R., 174, Corporation Street, Birmingham.. (1920-21)
WHISTON, H., 12, Hollings Street, Fenton .. .. .. (1920-21)
WHITELEY, A., 10, Stumpeslowe Avenue, Sheffield .. .. (1917-18)
WHITFIELD, T. S., c/o The Cobridge Brick Co., Burslem .. (1905-06)
WHITELEY, J. H., 11, Cambridge Street, Saltburn, York. .. (1918-19)
WIGAN COAL & IRON Co., Wigan .. .. (1916-17)
WILD, ARTHUR, Hawthorn Dene, Hathersage .. .. (1916-17)
WILD, R., The Wrose Hill Fireclay Co., Ltd., Car Lane, Shipley, Yorks. .. .. (1916-17)
WILLDIGG, L. J., Bromley Hough, Garden Village, Stoke-on-Trent .. .. (1918-19)
WILLIAMS, C. P., M.Sc., Brymbo Hall, Brymbo, near Wrexham .. .. (1916-17)
WILLIAMS, F. R., 1, Beaconfield Villas, Brighton .. .. (1902-03)
WILLIAMS, F. W., 4, Rosslyn Road, Longton.. .. .. (1905-06)
*WILSON, S. T., Park Works, Fenton, Staffs. .. .. .. (1904-05)
WITTON FIREBRICK Co., Ltd., Wear Valley Junction, near Darlington .. .. (1916-17)
WILKINSON & SON, S., Blackley Fireclay Works, Elland Yorks. .. .. (1916-17)
WILKES, F. L., Lyme Cottage, March Avenue, Wolstanton (1918-19)
WILTSHAW, & ROBINSON, Carlton Works, Copeland Street, Stoke-on-Trent .. .. (1916-17)
WINKLE, L. H., Colonial Pottery, Stoke-on-Trent .. .. (1908-09)
WONG, W. W., 131, S. Broadway, Los Angeles, California, U.S.A. .. .. (1918-19)
WOOD, A. R., c/o Pilkingtons Glass Works, St. Helens, .. (1920-21)
*WOOD, H. E., Hillside, Hamil Road, Burslem.. .. .. (1900-01)
WOOD, H. F., The Uplands, Brampton, Newcastle, Staffs. .. (1911-12)
WOODWARD, A., Prince of Wales Pottery, Sutherland Road, Longton .. .. .. P .. .. (1917-18)
WOOLLAM, H., 53, Pinnox Street, Tunstall .. .. .. (1900-01)
WOOLDRIDGE, F., Taylor, Tunnicliffe & Co., Hanley .. (1918-18)
WORKINGTON IRON & STEEL Co., Ltd., Moss Bay, Workington .. .. (1916-17)
WORTHINGTON, F. S., 5, Havelock Place, Shelton, Hanley (1907-08)
WRAGG, THOS., & SONS, Storrs' Fireclay Works, Loxley, near Sheffield .. .. (1916-17)
WRAGG, THOS., & SONS, Swadlincote.. .. .. .. (1917-18)
WRIGHT, J. E., 153, Cauldon Road, Hanley .. .. .. (1914-15)

The numbers in brackets denote the session of election.

Any change of postal address should be communicated to the Assistant Secretary,
A. RIGBY, Pottery Laboratory, Stoke-on-Trent.

Student Members.

BAILEY, W. E., 27, Buccleuch Road, Longton .. .. (1920-21)
BAILEY, W. M. Z., 5, Morley Street, Tunstall.. .. .. (1920-21)
BRADLEY, C. W., Woodleigh, Weston Coyney, Stoke-on-Trent .. .. (1920-21)
BREEZE, T. H., New Street Stores, Hanley .. .. .. (1920-21)
BURTON, W., 50, Havelock Street, Stoke-on-Trent .. .. (1920-21)

DERRY, B. R., Hazelhurst, Blurton Road, Fenton .. .. (1920-21)

HARDING, F. W., 6, Hassall Street, Hanley .. .. .. (1920-21)
HEAP, J. W., 9, Morley Street, Junstall .. .. .. (1920-21)
HORSLEY, G. M., The Lawn, Belper .. .. (1920-21)

JONES, A. E., Lightwood Chase, Longton .. .. .. (1920-21)
JONES, STANLEY CARTLIDGE, 14, Harrop Street, Birches Head, Hanley .. .. (1920-21)

MACE, GEORGE, 32, Paynter Street, Fenton .. .. (1920-21)
MAW, JOHN S., 13, St. John's Hill, Shrewsbury .. .. (1920-21)
MORRIS, J., 4, Foley Road, Longton .. .. (1920-21)

NEALE, J. R., Rushton Road, Cobridge, Stoke-on-Trent .. (1920-21)

PARTON, LEWIS, 22, Windmill Terrace, Smith Street, Hanley .. .. (1920-21)

RIGBY, J. H., 1, Buccleuch Road, Longton .. .. .. (1920-21)

ROTCHFORD, J., 39, Berdmore Street, Fenton .. .. (1920-21)
ROWLEY, THOMAS H., 63, Gilman Street, Hanley.. .. (1920-21)

SHIPLEY, W., Kingsley, Stockton Brook, Stoke-on-Trent .. (1920-21)
STANWAY, P. W., 65, Lichfield Street, Hanley .. .. (1920-21)
STEVENSON, SAMUEL, 59, Elm Street, Cobridge, Stoke-on-Trent .. .. (1920-21)
STEVENSON, SPENCER, 30, Eagle Street, Hanley .. .. (1920-21)

WILSON, N., Duke Street, Fenton .. .. (1920-21)
WOOD, H. F., Uplands, Newcastle, Staffs. .. .. .. (1920-21)

Proceedings.—Session 1920-21.

Open Meeting held in the Central Science School, Stoke-on-Trent, on Monday, 11th October, 1920. Retiring Chairman, Mr. Lewis Johnson, presided over an attendance of about 200. The following were nominated for membership of the Society : Collective: The Manchester Furnaces Limited and The Glass Research Association. Individual : Messrs. W. G. Barrett, C. Jacobsen, R. Pass, The University of Washington Library, N. C. Adams, S. Satch, B.Sc., V. H. Scott, J. W. Teale, J. A. Nardy, S. H. Futers, Institute of Science and Industry, R. M. d'Arleux, F. H. Rhead, A. D. Staton, E. E. Eley, J. B. Allman, R. Finn, and California University Library. Student : S. Stevenson (Cobridge), B. Ridgeon, C. W. Bradley, J. W. Heap, J. S. Maw, N. Meigh, H. F. Wood, S. K. Cope, R. Stubbs, H. Whiston, T. J. Leighs, S. Stevenson (Hanley), L. Parton, P. Stanway, W. Shipley, G. Mace and E. H. Coleman. Mr. Ashley Myott was unanimously elected President of the Society. Mr. Johnson vacated the Chair in favour of Mr. Myott. Mr. A. S. W. Odelberg read his paper "Some Further Improvements in the Manufacture of Pottery," and illustrated the paper by means of two cinematograph films. Mr. Odelberg replied to various questions put by Mr. A. Myott, Mr. T. Simpson, Dr. Beavis, Dr. Mellor, Messrs. A. Leese, L. D. Lovatt, C. E. Ramsden, G. Blair, A. E. Gray, J. Gimson and W. Emery.

General Meeting held in the Central Science School, Stoke-on-Trent, on Monday, 8th November, 1920. The President (Mr. Ashley Myott) took the Chair. About 75 members were present. A vote of sympathy with the relatives of the late Mr. M. L. Williams (Abergavenny) was passed. The following were proposed for membership :—Collective : The American Lead Pencil Company ; Individual : Messrs. E. C. Barton, G. H. Moss, S. Bentley, A. Rigby, S. Myott, T. H. Breeze. Mr. J. A. Audley, B.Sc., presented the Society with a copy of the Practical Potter, Part I. Mr. W. Lindley gave a paper entitled "Notes on Portuguese and Spanish Pottery." In the discussion which followed Messrs. F. S. Worthington, C. Bailey, D. F. W. Bishop, D. Singh, F. R. Wooldridge, S. R. Hind, H. L. Steele, C. D. Grimwade and the President took part. Mr. B. J. Moore read a paper on "Notes on Saggars," and a discussion followed in which the following joined : the President, Messrs. C. Bailey, D. Singh, H. L. Steele, H. E. Wood and Dr. Scott.

General Meeting held in the Central Science School, Stoke-on-Trent, on Monday, the 13th December, 1921. The President presided over an attendance of 60 members. The following were nominated as members of the Society : Collective : Davis, Turnbull & Co., Ltd. Ordinary : Messrs. T. B. Owen, F. J. Marshall, C. T. Mauritzen, F. L. Nobes, I. p. de Silva. Student : M. Wilson, A. E. Jones, J. Rotchford, W. E. Bailey, J. H. Rigby, J. Morris, W. H. Amison, J. R. Neale, S. C. Jones and C. Stanley. Dr. J. W. Mellor gave a short note with reference to Thorpe's ratio. Mr. Dogar Singh read a paper on "My recent visit to Swedish Potteries," and the following took part in the discussion : Messrs. W. Emery, C. D. Grimwade and A. Leese.

General Meeting held in the Central Science School, Stoke-on-Trent, on Monday, 10th January, 1921. Mr. B. J. Moore presided over an attendance of about 80. A vote of sympathy with the relatives of the following late members was passed :—Mr. W. Jackson (Founder of the Society) ; Mr. E. Mayer, Mr. J. Hollinshead. The following were proposed for membership : Collective : Messrs. Hill, Westlake & Co., Individual : Messrs. E. W. Oakes, J. P. Thorley, Dr. K. Endell, Col. Kent, Dr. E. W. Smith. The meeting took the form of a Question Box and questions were answered by Messrs. R. H. H. Jones, F. Turner, A. Leese, J. A. Callcott, B. J. Moore and J. Meredith. It was decided to continue the Question Box at a later meeting.

Joint Meeting with the Art Section held in the Central Science School, Stoke-on-Trent, on Wednesday, the 9th February, 1921. The President occupied the Chair and about 150 persons were present. The following were nominated for membership : Individual : Messrs. J. D. Black, W. J. Dolby, H. B. Cronshaw, B.A., Ph.D. ; Student : Mr. W. M. Z. Bailey. A symposium on Art followed to which the following papers were contributed : Mr. G. M. Forsyth : "Art in the Pottery Industry" ; Mr. H. J. Plant : "Pottery Design from the Manufacturer's Point of View" ; Dr. J. W. Mellor : "Toleration in Art."

General Meeting held in the Central Science School, Stoke-on-Trent, on Monday, the 14th March, 1921. Chairman—The President. There were 70 members present. The following were nominated for membership : Individual : Messrs. J. C. L. Edwards, C. R. Threlfall, A. F. Graves, L. J. Holloway, W. H. Yates. Messrs. A. Heath and A. Leese read a paper on "The Effect of Calcination of Flints on Earthenware Bodies," and Messrs. B. Moore, C. D. Grimwade and Dr. Mellor contributed to the discussion. The Question Box from the January Meeting was also concluded.

A meeting in conjunction with the National Council of the Pottery Manufacturers was held on Monday, 11th April, in the Central School of Science, under the chairmanship of Mr. Ashley Myott. About 70 attended the meeting. The following were nominated for membership of the Society: Individual: Messrs. A. E. Werner, A. Fry, C. J. Chambers, A. R. Wood, J. Goodwin. Mr. D. F. W. Bishop read a short communication as an addition to the discussion on the paper entitled "The Effect of Calcination of Flints on Earthenware Bodies." Dr. A. Stanley Kent, assisted by Mr. F. J. Adlam, gave an address on "Industrial Fatigue."

General meeting held on Monday, the 25th April, 1921, in the Central School of Science. Chairman—Mr. Ashley. 80 members were present. The following were proposed for membership: Mr. Stanley Brooke, The New York Public Library. Mr. Ashley Myott delivered his Presidential Address. The Annual Report of the Council was read and officers were elected for the next year. Miss A. B. Taylor, B.Sc., communicated a short paper on "Plaster of Paris," and Dr. J. W. Mellor communicated a paper on "Decomposition of Clay." Mr. Bernard Moore gave a paper "A System of Elutriation for Potters," and a short discussion followed, in which Dr. Mellor and Mr. A. Heath took part.

Proceedings of the Refractory Materials Section of The Ceramic Society.

Session 1919-20 and 1920-21.

General Meeting held at the Central School of Science and Technology, Stoke-on-Trent, on Wednesday, 28th April, 1920. Chairman—Sir William J. Jones. Ald. P. Elliott, J.P., welcomed the visitors to the district. The following papers were read: "Carboniferous Grits of Denbighshire and Flintshire," by Mr. T. A. Acton, F.S.A.; "The Refractory Materials of the North Staffordshire District," by A. Scott, D.Sc., M.A.; "The Determination of Zirconia," by H. V. Thompson, M.A. The following paper was communicated by title, "The Decarbonation of Canadian Hydro-Magnesite," by Miss E. Uren. Sir William Jones exhibited and described an Oil-burner from a glass works. In the evening the members and friends dined at the North Stafford Hotel.

On Thursday, the 29th April, 1920, the meeting was continued and a business meeting was held in the morning. The following were elected members of the Society:—Individual: The Clay Ring Co., Ltd., Mr. J. Paine, Mr. W. R. Jones, Mr. R. C. Rann, Societe des Produits Céramiques et Refractaires de Boulogne s/Mer. Mr. W. J. Rees was co-opted a member of the Council. A symposium on Gas Firing followed in which the following took part: Dr. E. W. Smith, Messrs. T. Wilson, J. H. Singleton, Wm. Leckie, A. Fielding, C. W. Thomas, H. M. Ridge, H. H. Bailey, and J. Williamson. During the afternoon a number of works in the district were visited, and in the evening Dr. H. E. Armstrong lectured on "Potter's Clays," Mr. R. Lewis Johnson presiding.

General Meeting held on Saturday, the 14th May, 1921, at the Hotel des Ingénieurs Civils, 19, Rue Blanche, Paris. Chairman—Sir Wm. J. Jones. The Chairman mentioned that on account of the Coal Strike of 1920, the Autumn Meeting had been abandoned. Col. C. W. Thomas was elected President of the Society, and in accepting office remarked that he would do all he could to help forward the work of the Society. Sir W. J. Jones then retired from the Chair and Col. Thomas presided. Sir W. J. Jones was thanked for the excellent work he had done as President and Chairman and he responded in a suitable manner. Dr. J. W. Mellor communicated a paper "On the Plasticity of Clays." The following papers were also given: "Resistance Tests on Refractory Products under Load at different Temperatures," by V. Bodin; "Dinas Bricks of Constant Volume," by Prof. O. Rebuffat; "Some of the Difficulties experienced in maintaining a Pyrometer Installation in a works," by Mr. R. S. Whipple; "Notes on American Practice in Refractories," Mr. W. J. Rees, and a short discussion on the latter brought the meeting to a close.

I.—Introduction to Symposium on Art.

The Chairman, in his introductory remarks, observed that this year the Ceramic Society attains to its majority, and it was pleasing to reflect that whilst the commencing years of its life were full of troubles and difficulties, with courage these had been overcome, and he thought it could now fairly be claimed that the Ceramic Society ranked as a power in the pottery world, and stood high in the esteem of, at any rate, the thinking section of those who were engaged in the pottery industry. He welcomed the holding of this joint meeting of the mother and daughter sections of the Society. There was no room for any feelings of rivalry or jealousy between the two. The parent section of the Society recognised that the daughter section had a distinct mission to fulfil—that of raising the artistic standard of the productions of the industry—and looked forward with great pleasure to hear of her continued and increasing success year by year. He sincerely hoped that this first united meeting of the two sections might not be the last of its kind, but merely the predecessor of many similar meetings. Without flattery he thought it might be said that they were all highly favoured in having the subject of art in the pottery trade presented to them from such a variety of standpoints as would be evidenced in the treatment of it by Mr. Gordon Forsyth, Mr. Harold J. Plant, and Dr. J. W. Mellor. As a member of the British Pottery Manufacturers' Federation he would like to take the opportunity of saying that he and his colleagues were anticipating that great good would result from the efforts which Mr. Forsyth was about to make, in his new capacity of art adviser to the pottery manufacturers, to improve the productions of their individual factories. With regard to the second speaker, Mr. Harold J. Plant, he (the Chairman) knew of no manufacturer who was more fitted to contribute to the discussion from the manufacturers' point of view. When they remembered that from Mr. Plant's factory there went forth the celebrated "Tuscan China," they realised all the more powerfully how art could be wedded to utility to produce a harmonious whole. The third contribution would be by one to whom not only the Ceramic Society, but the whole of the pottery world, owed a deep debt of gratitude—Dr. Mellor. The indefatigable and painstaking efforts which Dr. Mellor had displayed in his research work for the industry did not require emphasising. It was quite possible that Dr. Mellor, with the keen, accurate view of the scientist, might possibly desire to cross swords, in a friendly sort of way, with the poetic licence of which Mr. Gordon Forsyth, actuated by enthusiastic impulses, might feel justly entitled to avail himself, but they felt sure that in Dr. Mellor's remarks they would once again have evidences of that keen wit and humour which were so characteristic of him.

Art in the Pottery Industry.

By Mr. G. M. Forsyth.

BEING an attempt to clear the air of vapid theorising on art as applied to modern production, to bring back to the Industry sound principles of design and craftsmanship, and the appreciation of pottery for its own sake.

Note—The word "Art" is used throughout to signify work evincing practical skill in the creation of beauty, and the word "Artistic" (a sadly misused word) as containing the elements of common sense and healthy Art.

Somewhere about the year 1700 an early English potter inscribed in slip on a drinking cup, *"The best is not too good,"* whether he referred to the pot or to the best home brewed is a moot point. Anyway, it is an excellent motto, and I have no doubt but it was the creation of one of the progressive manufacturers of his time, however insignificant he might look when placed against our smallest manufacturer of to-day. It has been the motto of every English potter down to the present day who has contributed to the advancement of this great industry.

"Only the best is good enough," and the supremacy of English Pottery still depends on "Only the best," in Art as it has already only the best in Science.

The beginning of wisdom is in the veneration of one's craft and no craft is more worthy of homage than the craft of the potter, because in it is enshrined the very dawn of Art. Its origin is lost in the Mists of Antiquity, and yet to-day, it holds for us a wondrous fascination as of yore, it is an ever fertile field for victorious accomplishment in the happy union of knowledge and beauty, enabling us to become creative Artists—adding what quota we can in the hope that those who come after us will build even better than we have built.

Probably no subject under the sun is more elusive than a discussion on art, and to the purely scientific mind the art side of our craft must present a somewhat chaotic or cubist effect.

A scientific fact once demonstrated and proved is accepted and acted upon—it becomes a material truth—but Art cannot be measured by a two-foot rule, nor can an adequate definition be found although libraries can be filled with volumes on what is Art or what is not Art?

It is indeed very questionable as to whether theorising on Art serves any useful purpose at all, because after all is said and done, the only REAL thing that counts is practical accomplishment, the reduction of ideas into real and tangible actuality.

Much as one is tempted to dip into the history of the craft, I will pass lightly over it as a sacrifice to the needs of the moment, but what potter is not thrilled at the sight of a piece of lovely Egyptian turquoise of some 6,000 years ago.

The modern pottery designer can claim kinship with the glorious artists of the Sung dynasty, and their great brothers who worked for Shah Abbas, with sublime Euphronious, Maestro Giorgio, Thomas Toft, and with all lovers of the craft who have written their names legibly in this imperishable material. These revelled in the plastic quality of the clay, and their decoration was the expression of their joy in their work. Sometimes crude, sometimes superb masterpieces of craftsmanship, but all imparted to their work a sincerity that is undeniable and a glorious independence that made them supreme artists. All these loved their craft for its *own* sake.

To trace the development of any particular style is an interesting study (and a comparative study of various styles in ceramics can be fascinating), but the early work in any style very often contains a virility that is lost in their more accomplished productions. (Vide Han Sung in comparison with Yung Chéng or Chien Lung).

The natural trend of all styles may be roughly taken to comprise crude early work, a period of gradual artistic rise, a period of flowering excellence and then decay. Luxury and ostentation are usually responsible for decline and death (we are in the happy position of being a long way off the luxurious period).

One of the great qualities of pottery is its complete independence of architecture when all other art crafts are more or less subserviant. Not only is it free from this thraldom, but it is also more permanent than Architecture, Parthenons vanish while Pottery of twice the age remains as fresh as the day it was drawn from the kiln. This imperishable nature of our material is a paramount reason as to why it behoves us to treat the craft with the utmost respect and veneration.

Fortunately, the great majority of manufacturers have a real pride for their craft, and it is a constant joy to produce a well-made, well glazed and well decorated article. It is, of course, an absolute necessity that his business should pay, for no Manufacturer runs his business either in the interests of art or of science, but a craft that is essentially an Artistic craft cannot be divorced from Art and be successful.,

The application of living healthy artistic ideals to pottery manufacture means the soundest economy, and is essentially a business proposition for the designer or the artist has the last word in production, and the effect of his work is first to sell the goods. It means that good workmanship replaces bad, and that commonsense beauty replaces extravagent ugliness, wherever it exists in any grade of ware for any market in the world. There is to-day an incessant and increasing demand for well decorated pottery of a

purely utilitarian type, and manufacturers know it; but how to supply this demand is not an easy task for them.

The problems of to-day are not the same as the problems that faced Josiah Wedgwood, that towering romantic figure who was the first to apply scientific methods of production in English Pottery. He was pre-eminently a scientific genius with a great conception of his craft. He employed the best artists of his time in producing exquisite examples of rare restrained and classic beauty with such skill and care that to think of English Pottery was to think of Wedgwood. He laid the very foundations of modern production. In its proper sphere (that is in a classic room or on an Adams mantlepiece), I cannot think of anything being more beautiful or more refined than some of his original shapes, but, however beautiful this was in the hands of the great Maestro, it led smaller men to the wholesale copying of foreign styles, and English Pottery became anything and everything but English. It ran riot through Greek, Chinese, Dutch, German and French styles, and culminated in a welter of realism amazing in craftsmanship but devoid of even elementary principles of what constitutes sound Art. *There is a vast difference between designing a style and mere copying without understanding.*

We are reeling to-day from this debauch and groping for the right point of view as to what constitutes good pottery decoration, in the hope that we will eventually evolve a style that is all English.

There is no need for pessimism on this point. Already there is ample evidence from many manufacturers that they are appreciating the beauty of a clay shape and the quality of line and colour that only pottery can give.

There is a vigorous and healthy artistic movement emanating from *inside* the pottery trade, and it is impossible to omit referring to the splendid work of the Art Section of the Ceramic Society. The work of the Society is purely constructional, and has amply justified its existence. It is strongly supported by large manufacturers, as well as small, by connoisseurs, by educationalists, and by all the best and most progressive men in the district whose only desire is that the best interests of the craft should be promulgated for the progress of the community as a whole. The Art section is making history, because whatever virtue there is in criticism, the only real reform can come from the practical constructional work of our professional potters inside, and not from amateurs outside who have little or no conception of the immensity of the trade, appreciation of its traditions, or in its possibilities in artistic treatment.

The advent of William Morris created a new phase in the war against ugliness (although this great warrior was only indirectly, through William de Morgan, connected with pottery). He led a crusade in the interests of Art, creating a School of Craftsmen which was violently opposed to all manufacturers. To-day, this same school is fully aware that only by the co-operation of the manufacturers can any real progress be made, and that catering for

the new art as applied to mass production is of infinitely more consequence.

English designers are the finest craftsmen in the world, but the supremacy of British Pottery can only be maintained by increased attention being paid to the artistic side of the craft. Most of our large firms are well equipped with competent designers or art directors, but many small firms rely upon "Adaptor" whose time is largely spent in giving out prices and settling for work in the decorating department, or of making the best of untractable transfers. Little or no time is given to design, a knowledge of processes, or to the study of the historic side of his craft, and under conditions imposed on him the handicap is so great that even moderately satisfactory results are well nigh impossible.

One man designs the shapes, another designs the decoration, the decorating manager cuts out as much as he dare, and the traveller wants more on, the buyer is held in fear and trembling, and rarely is the work considered from beginning to end by one mind. Skilled handwork is the basis of all mechanical processes in the decoration of any grade of ware, and the appreciation of fine handwork could re-vitalise the present poverty in design of mechanical processes. When manufacturers realise the economy of Art in the employment of skilled craftsmen unfettered by tasks that are taken for granted, and in the adequate payment of the best designers and modellers, British Pottery will simply leap forward.

Room must be made for the designer in place of the adaptor but, not only must we have skilled designers, but skilled executants working under the best conditions in clean and well lighted workshops.

Every man or woman of average intelligence, can become an accomplished artist or craftsman by training on sound lines, craftsmanship is 99 per cent. of all Art.

An Artist is a man or woman who has the brains to do his or her work with superlative skill and ease, intensly practical, gifted with a sense of beauty of form and colour, an imagination, creative ability, and an instinct for quality in any Art or Craft.

Every Artist must be skilled in the manipulation of his materials before he can express his individuality in tangible terms. His work is characterised by its restraint, its sense of fitness for its purpose, and if it is a teacup or plate of common and everyday use, it can become a work of Art. He imparts life into a dumb and dead material.

Our whole conception of Art as applied to industry has been deliberately obscured by the popular superstition that only picture painting is art, but the art of the potter is an infinitely more precious thing than the painting of pictures. Another great piece of humbug is that an Artist has to wait for some divine inspiration—*all great Art is accomplished with the greatest of ease.* Any tortuous evolution of a design for anything, whether it is a picture or a piece of pottery,

is a fatal error in producing a work of Art.

Even difficulties of execution in any way are fatal errors in artistic production. The successful artist or designer works with unerring intuition, and takes every factor into consideration, for Art is nothing more or less than the best use of a material in the hands of a skilled man.

The aim of Science and the aim of Art is exactly one and the same thing, and neither can exist apart. Our scientists have provided better methods of manufacture and enlarge from day to day the possibilities of colour effects, but without the artist to use these rightly, they might as well remain in oblivion.

It is comforting to think that the best productions of to-day will be carefully preserved for all time, and that the whole of the artistically bad will vanish and be forgotten.

English Pottery has a great tradition, and it is our duty to maintain this great heritage, otherwise, the past is of little or no consequence save where honest work inspires us to produce even a higher standard for our own day and generation.

Good work and bad work have existed side by side in every style; the good survives while the bad goes spark out.

The question of whether a piece of pottery is decorated by hand or whether some mechanical process is used matters very little, for handwork can be quite as bad or as dead as any mechanical process, but our humblest productions that have in them some simple beauty will be preserved when most of our more ambitious attempts are lost and forgotten. We deliberately degrade our craft, and then moan about it, saying that we have no skilled men, or we take refuge in saying that "This is what the public wants," pure humbug and subterfuge.

The workmen of to-day are quite as good or even better craftsmen than ever they were, and the same stories were used in the thirteenth, fourteenth and fifteenth centuries, before English Pottery was in existence.

The public have no means of expressing their wants, they buy what is best value for their money, and what the potters give them.

All men and women are artists in some degree or another by the mere fact that they are capable of appreciating beauty and desire it.

The artist has a niche in the scheme of things as everlasting as the hills, and in our own particular craft we have to thank modern scientists like Wm. Burton, Dr. Mellor and Bernard Moore, men of our own day and generation, who have revealed for us new springs of inspiration by their knowledge, understanding and practical achievement as to what constitutes beautiful pottery.

Every manufacturer has it in his power to add something to the great tradition of English Pottery, a craft that is a pleasure and even a privilege to work in, its scope is illimitable.

It is the bride of the ages, elusive, forever beautiful, and gifted

with eternal youth.

Ten thousand years after this artists and scientists will still be engrossed in the quest for beauty in Pottery production. Not all of it can be revealed to us.

We are justly proud of our beautiful white ware that shines like snow in summer, throwing back the sparkling high light that is living. What are we doing to-day to fashion it into a shape of everlasting joy or clothe it with the garment of praise. Only a poet can do justice to the beauty of our craft. As yet no English poet has risen to the occasion (the day may not be far distant when they will) , but let us make the nation's pots and whoever will her songs.

"*The best is not too good,*" and when we bring back to the industry the spirit of true craftsmanship in every branch of the trade, then will English Pottery outstrip anything that has ever been accomplished by any age and by any race.

Art is indestructible—whatever the prevailing style may be Babylonian, Egyptian, Greek, Roman, Byzantine, Chinese, Persian, Celtic, Gothic, Renaissance. All were evolved from the same fundamental basis, and all possessed an everlasting beauty.

However divergent Greek, Chinese and Celtic became, the early work in each style proves up to the hilt that *unknown to each other*, all started in the very same way, and surely as we get a grip on the common basic principles that built up the glorious traditions of these styles, we can build a 20th Century English Style as characteristic and as beautiful as any.

Time is the great adjudicator, and who knows that out of the seeming chaos of the moment, a great and glorious style will emanate. I am optimistic enough to believe that this will happen, and that the potters will lead as they have done before. It is the humbler crafts that build up the bigger crafts, it is the potter that makes the Architect.

What we want is an honest pride in our craft for its own sake, for the rare and permanent beauty it is capable of and to strive to make it by the help of Modern Science more beautiful everyday.

Pottery Design from the Manufacturer's Point of View.

By Mr. H. J. Plant.

THERE never has been a time like the present for advance in every direction, and in art the feeling is particularly strong for something original in conception to express the spirit of the age, which could be handed down to posterity as English 20th century art ; whether this is possible remains to be seen.

With all our facilities, and wealth of glorious old masters' works to hand, the rising generation has every opportunity; but can it be done? Does not the rapidity with which we live in these days preclude all chance of creating such a land mark ?

It appears almost as difficult to bring forth a period marking style of art, as to erect an edifice on shifting sands.

Take pottery design—No sooner have the foundations been laid, and goods launched on the market, when (if particularly good), a run will be made on this style of design, but it is only transitory, the cry will go up in a short time for something different in every respect.

New foundations have to be laid in a fresh field, ones knowledge and experience is not accumulative to the full extent, any particular design is not long enough in vogue to give sufficient chance to build to perfection on the idea. The conditions of life now are so vastly different from the real old days. Everything to-day is working on top gear. Public fancy changes with great rapidity.

A craze or fashion reaches its zenith in no time, with the inevitable result that people become nauseated and lean favourably towards the other extreme. These are some of the facts one has to face when striving to create a style of art expressing the age.

A great deal of discussion has taken place from time to time about Ceramic Art, and various expressions of opinion have been given by art masters on pottery design. Many of these critics in their craving for the ideal, are apt to forget such things as price, easy manipulation, and practicability of any given pattern.

In the keen days ahead, *price* will be a very powerful factor, therefore the artist must put on ware designs combining the maximum of effect with the minimum of labour, and of such a nature as to appeal to the million. No matter how good a pattern may be, if it does not meet with approval, it is a failure from a commercial point of view.

To try and force on the market ones own pet fancy, even if backed up by all the artists in the kingdom, is sheer madness, and simply asking for bad trade.

The potter can but advance with the times. Pottery is not powerful enough to sway the nation's fancy. The most successful designer is he who keeps well in touch, and is ever playing up to the public, following every fickle fancy, and working every craze to his utmost capacity This requires breadth of conception. The man with fixed ideas is incapable of producing patterns to suit all markets.

A decorator is not long on a factory before he recognises the necessity of sinking some of his ideals, if he is to hold the position. Success depends to a large extent on whether he has sufficient vision to adapt himself to all classes of trade.

I do not infer by this that he must be willing to produce designs having no artistic merit, but that his designs must be beautiful in a way that will appeal to the people for whom they are made. A man with a fixed idea, such as the futurists seem to have, will stand a poor chance as a designer for pottery.

Take for an instance—Certain designs produced by a capable man were approved at the Ceramic Society's adjudication last year, but knowing from experience the public taste, another range of samples was made, and both lots put on the market together, with very discouraging results to the adjudicators approved works. The patterns done to suit the market had a far greater sale than the conventional art designs. The prices of both lots were very similar.

The kinds of work very much appreciated throughout the country were borders with naturalistic rose sprays tastily displayed underneath, also roses with narrow brown borders underneath, festoons, scattered flowers, flowers connected by choice bits of ornament, and various other styles suitably colored to meet the present day fancy.

Judging from previous experience, this class of work would simply be shot to pieces with criticism from the adjudicators of the Ceramic Society. Nevertheless, they convey a pleasing effect to the eye, and met the approval of the majority of buyers.

It is a well known fact that utter rubbish is produced, which is devoid of all the principles of design, and has neither tasty color scheme nor beauty of line to recommend it. Such work certainly does want checking. It is generally produced on the lower grades of ware, sold at a cheap rate, and is to be found in large quantities all over the country, contaminating everything with which it comes in contact. The crockery shops in most towns show an utter lack of taste in placing ware, beautiful and delicate designs will have accompanying them, black and red underglaze Derby well splashed with liquid gold, with the result that the delicate pattern looks lifeless by contrast, and the Derby twice as vulgar.

Great harm is done to the advancement of art by such lack of judgment, and is accountable for many good patterns not selling in certain shops. The question is, how can we make pottery more artistic, and at the same time keep the works going strong. Re-

peated experiments have proved that it is necessary to give the public what they want, therefore, that is the first consideration. Secondly, always have certain patterns of real artistic merit to satisfy the higher tastes in art.

The manufacturer can do no more than eliminate, as much as possible, all vulgar samples, and keep up with the times, trusting that better education throughout the country will advance the taste of the rising generation.

Considering the choice works in vogue during the early part of last century, and comparing the same with the bulk of work done to-day, one does not feel too rosy about the future of art. Art to-day seems very unstable, no two men appear to have absolutely the same criticism to pass on a design. Most extraordinary paintings are now being produced, in an endeavour no doubt to arrive at something tangible.

In training a boy for the position of Art Director, it is desirable he should have some knowledge of chemistry, and potting generally. To produce designs is only half the battle; so many technical difficulties have to be taken into consideration for successful execution. Potting has sufficient troubles, which are unavoidable, without adding unnecessary ones. Once having mastered the possibilities and limitations of pottery, the young designer is not likely to waste time on any impracticable schemes.

A knowledge of chemistry broadens ones field of production; coupled with art a man becomes complete. Few trades will give him greater opportunities for testing his ability in both directions, than potting.

The thousand and one tantalizing difficulties which will persist in cropping up, day after day, lose half their seriousness when one is well armed and equipped with knowledge to tackle them. Instead of being worried and annoyed when some unlooked for problem crops up, the chemist smiles, pulls himself together, and really lives; the desire of conquest becomes hot; one can see him polish the microscope, and bubble up with excitement over a small piece of pitcher, which to the ordinary individual, appears as nothing; but to him that small bit of pitcher contains the solution of a difficulty, or may be the seed of a discovery—probably a new colour or glaze rests in the cradle of existence. What an asset to have the chemical knowledge of colours, oils, materials, etc., making it possible to produce anything to suit ones own designs, and to feel the grip of pottery decorating from A to Z within ones grasp.

To sum up, fashion changes so rapidly that it is almost impossible to adopt any permanent style of design.

We have no need to live in the past; present day productions are the best of all. Chemistry is a necessity to-day in the application of design to pottery. Meeting the needs of the buying public does not mean that the artist must produce rubbish. It simply means that he must mix a large proportion of common sense with his colours.

A Plea for Toleration in Art.

By J. W. Mellor.

Myself when young did eagerly frequent
Doctor and saint, and heard great argument
About it and about; but evermore
Came out by the same door, where in I went.—
Omar Khayyám.

IN many conversations I have had with Mr. Forsyth on Art, I have been in such close agreement with him, that I have looked forward with agreeable pleasure to a discussion on Art between the two Ceramic Societies related as buxom daughter, and proud mother. My own part in the discussion is simply that of a student groping for some sound principles on which to base his opinions, but who, up to the present, has signally failed in his quest. Socrates and a host of others have made utility the test of beautiful things; and the first named added that a thing cannot be beautiful unless directed to an end that is good. Numerous other suggestions have been made, but I know of no quality which beautiful things possess in common. The ingenuity of twenty-five centuries has failed to find a satisfactory answer outside personal idiosyncrasies. I was lucky in persuading Mr. Plant to give us his ideas from the manufacturer's point of view so as to keep us from the "vapid theorizing" which Mr. Forsyth so much condemns.

Mr. Forsyth virtually says that the term Art means practical skill in the creation of beauty. I wonder if I should be wrong in understanding him to mean that Art is rather a product of the perception and love of beautiful things. If so, I accept the implication that Art is a means of recording or chronicling the artist's insight into beauty; and it is another name for beautiful productions whether they be pictures, pots, poetry, music, dress, essays, religion, politics, etc. If this be provisionally accepted, the discussion is merely deflected to an inquiry as to the meaning of beauty as an abstract noun, or of beautiful as an adjective, for it will be obvious that when a manufacturer enquires: What is an artistic pot? and he is told that it is a beautiful pot, he naturally wants to know if there is any standard by which he can judge when a pot is beautiful, and when ugly. The question is not a trifling one, since, by definition, it is equivalent to asking: When is a pot artistic and when not artistic?

Mr. Plant seems to imply that the great buying public does not always want the patterns of real artistic merit, and that he would reserve such patterns for those possessing higher tastes in Art. He even showed that the attempt to compel the public to buy patterns favoured by our leaders in Art would mean ruin and bankruptcy. No good is served by shirking this issue. In the example Mr. Plant

quotes, other things being equal, I cannot imagine the public in general buying inartistic or ugly pots when they can buy artistic, pretty, or beautiful ones. I therefore beg to submit the proposition that *there is something fundamentally wrong in our definitions of artistic or beautiful pots.* The importance of this proposition is emphasized by the fact that the individual members of an adjudication committee are not always in agreement as to what is beautiful, and what is ugly. Pieces condemned by one member as ugly and inartistic, are appraised by another as artistic and beautiful.

The standard of beauty in Art has been a fruitful source of discussion ever since the time of Socrates and Plato, three centuries before Christ. The enquiry has been mainly directed to finding if we gain our standard directly from nature herself, or if we have an ingrained special sense which can be cultivated or atrophied, and against which there is no appeal. Ruskin said that:

> "Why we receive pleasure from some forms and colours, and not from others, is no more to be asked or answered than why we like sugar, or dislike wormwood."

and Darwin added:

> "No doubt the perceptive powers of man and the lower animals are so constituted that brilliant colours and certain forms, as well as harmonious and rythmical sounds give pleasure and are called beautiful; but why this should be so, we know no more than why certain bodily sensations are agreeable and others disagreeable."

It is said that the different styles of Art, however diverse, are all built on the same basis. In looking for that basis, I was reminded of a report by one of the papers in which it was said: "It is extraordinary what results the pottery artist obtains with such simple materials as straight and curved lines and the seven prismatic colours." The "same basis" in the different works of early Art can be attributed to the fact that so far as general features are concerned, all were copying the same natural objects.

I believe that the majority is agreed that we inherit a so-called *aesthetic sense.* Be this as it may, there is certainly no agreement as to the standard or criterion of beauty. The answer may be that which St. Augustine gave of Time, "If you ask me what it is, I do not know, but if you do not ask, I know," but this lets us out by the same door we entered. As a working hypothesis, I suggest that *each individual's judgments of what is beautiful or ugly are largely determined by his environment, by his past history, and by his temperament.*

There are fashions in Art, as in a good many other things, so that certain characteristics at one time cultivated as desirable attributes, are condemned at another time as undesirable accretions. As Hogarth stated in his *Analysis of Beauty,* the most incongruous

dress does not appear ugly after it has been used for a time, and custom will make us satisfied with one fashion until a new one appears. A dream of a hat one season may, the following season, be an ugly nightmare. The tricks a costumier plays with woman's dress and figure, as the fashions come and go, illustrate, I think, that the standard of Art is dependent on environment.

Again, when the mind is young and plastic, it unconsciously acquires certain indelible impressions, which give an unconscious bias enduring all through life. In countries where men's faces are bare, men with beards are regarded as horrors. The practices of certain nations tatooing the body, painting the skin, putting skewers through the nose or lips, elongating the skull, or distorting the feet, are not regarded as deformities, but are presumably intended to enhance the beauty of the human form. The Hottentots can perceive more loveliness in their—to us—ugly Venus than in the—to us—beautiful Grecian Venus of Melos. Thus a design may be regarded as beautiful in one country, and hideous in another. There are designs which to us are beautiful and artistic, are blasphemous and ugly to another nation. The canons of Art are very different with different peoples; and perhaps to a less extent with the same peoples trained in different schools of Art.

I think the world is largely ruled by temperament; we like to pretend that reason and logic prevail, when, as a matter of fact, our religion, our politics, and our general outlook on the world are largely determined by our temperaments and not solely by logic or reason. The effect of temperament on our judgments is extraordinary. We are sometimes small-minded enough to perceive only the faults in the work of those we dislike, and only the beauty in the work of those we like. We go through life wearing spectacles colored by our own tastes and prejudices; and in general, the attitude of an individual's mind towards any particular object or phenomenon is mainly determined by his temperament. Certain charms in a woman may attract one man and not another; one man marries a drooping eyelid, another a dimpled chin, another a supple waist, and still another a bewitching ankle.

Fortunately, or unfortunately, some people are so constituted that the outsides or the externals of things have nothing like the attraction for them as have the workings of the insides of things. To this type of mind the wonderful play of physical and chemical forces at work during the maturing of body, glaze, or enamel in oven or kiln, and the marvellous effect of the different processes of manufacture on these results, appeal far more than all the beautiful designs collected in our museums. Again, one man might be more impressed with the beauty of the internal mechanism of the body than with the outer shell; another man might admire the beautiful harmony in the external form of the human figure, and be horrified if the skin were removed and the muscles and nerves exposed, or if the body were viewed in the

X-ray apparatus so as to show the marvellous skeleton. To one, it might appear a sacrilege to analyse the blush on the maiden's cheek by showing how the nerve system regulates the flow of the blood. Most of us would think that the tears of emotion in Madame Balthazar's eyes did not awaken the finer feelings in her husband's mind for he had already taken the opportunity of collecting and analysing them. *Les larmes, dit il, contiennent un peu de phosphate de chaux, de chlorure de sodium, du mucus, et de l'eau.* I might add that the analyses want repeating to find if the composition of tears varies with the different emotions.

I have tried to show that *the standard of Art or beauty varies with the individual's temperament; it varies with a nation's customs, traditions and habits; and it varies with time, and changes with the prevailing fashion.* When, therefore, the half-dozen judges in one exhibition condemn a class of ware as "bad art," I interpret the decision to mean that the committee has succeeded in getting six men whose opinions are alike in certain respects. When Mr. Plant tells us that he would "reserve certain patterns for the benefit of those with a higher taste in Art," I interpret that to mean that his own private opinion of what is beautiful does not always coincide with the majority of his buyers, and that those whose selection comes nearest to his own have the more cultivated taste. When a man claims that "the public taste wants educating," I understand him to mean that the public taste differs from his own, and that he would like some missionary work done to try and get their standards in harmony with his own.

It has recently been argued that a pot-shape is beautiful only when it retains the essential quality of the material from which it is made—in clay, plasticity. I cannot see this at all. The shape of a teapot, obviously imitating old silver teapots, cannot on this hypothesis be beautiful, when it suggests rather a-plasticity than plasticity. I think this is all wrong. The teapot in question *per se* may be superlatively beautiful to me; and if it had had the luck to have appeared in the world before the silver pot, it would never have suggested a metal at all. Of course, I am not arguing that there are no atrociously shaped teapots; but I believe, rightly or wrongly, that such pots would never be manufactured if they were not somebody's darling.

I see here little prospect of educing a general standard or test likely to be any practical use. I would avoid dogmas in Art as a plague until we get satisfactory standards. I deny the right of any man to say that an object beautiful to me is ugly in the abstract, though it may be ugly enough to him; and I likewise deny the right of any man to say that my politics are wrong in the abstract although they may be wrong enough to him. In Art and Politics I am a strong Individualist—*quot homines, tot sententiæ,* so many men, so many minds. In the past when the majority has considered that a man's Religion and Politics are inimical to the

well-being of the community, he has been persuaded to orthodoxy by a little sizzling on red-hot coals, or else he has had his head chopped off, or he has been deported. We are a bit more tolerant now, and I plead for a little more toleration with the public's 'doxy in Art.

An apology is perhaps needed for the trend of my remarks. My original intention was to examine the bearing of Science on the Art side of the potter's craft. I could make no progress, because I could find no common ground from which to start. Although the objects of the application of Art and Science to the potter's craft lie in the same direction, the methods of the one are the antithesis of those of the other. So far as I can see, Art is mainly concerned with emotion and sentiment, and its language is suffused with poetic metaphors which from their very nature lack precision. However unsuccessfully, Science tries to do her work in the opposite way, and she looks askance on language which is intended to sway the emotions and sentiments.

However much we enjoy what one might call the lighter side of Art or Science; when we are actually at work, we must have precise concepts for our terms. The difference between Art and Science is very clearly emphasized in their language. I used to enjoy our old friend William Burton, when in a fit of enthusiasm he would let himself go and tell me that a lustre effect resembled "the shimmering opalescence on the breast of a dove." I suppose it is all right, I have seen only the turtle variety of dove when the lights in the cinema have been unexpectedly switched on. Mr. Forsyth has also given us a few of these descriptions. I am not objecting to them—in fact I usually, not always, like them—but when our concepts of Art are clearer, we shall have to use more precise language excepting when we are in a poetic mood.

Our descriptions of colour are very shocking. If a test were made, I think there would be some differences of opinion as to what particular shades of colour are denoted by the terms apple-green, grass-green, pea-green, etc. I can imagine future historians demonstrating that our sense of colour is not well developed, because they may have good grounds for saying that the people of the 20th century were so colour-blind that they actually called yellow and purple colored wines respectively "white and red wines;" and flea-brown coffee was called "black coffee or café noir." A man cannot be frightened as "white as a ghost," but his bloodless skin may appear dirty yellow. We say that a girl has sky-blue eyes, when they are really the colour of slate; that she has "ruby lips or cherry lips," when they are really the colour of Accrington facing bricks; and that her skin is "white like the hawthorn buds that open in the month of May" when the real colour is not unlike that of a Swede turnip. I beg to suggest that very useful work can be done by the Art Section of our Society in standardizing the names of colours.

DISCUSSION.

MR. G. M. FORSYTH:—My friend Dr. Mellor would have us believe that he enjoys the lighter side of Science and Art. His modesty is becoming, but I think he is more serious than he would have us believe. His reputation in Science at any rate leads us to think that he may even take Art seriously someday. When he sees nothing wrong in taking a cast of a metal teapot and upholding this as right and justifiable in pottery, I feel he has got in at the deep end and wants rescuing. When he aserts that he thanks no man for interfering with his politics, taste in Art, and that he is a strong individualist, it seems to me he is going under for the third time.

Dr. Mellor is too much of a scholar not to have based his beliefs in what he knows or thinks to be true and too much of a student not to be able to change his views on any fresh conception of truth. Only at the age of twenty are we quite sure on anything. What Dr. Mellor fails to understand is that there is a real difference between clay and granite, metal, wood, and glass, that each of these materials impose certain limitations recognised by the Artist. The nature of the material is a dominant factor in Artistic production. Mimicry may be quaint and interesting as a freak, but I want to know why we should sacrifice the natural beauty of pottery for that of any other material. The early Chinese potters of the Han Dynasty imitated bronzes, but that was before they were skilled potters. The Greeks did the same, the early Italian painters painted pictures that resembled Gold Mosaics in the Byzantine manner, but it was not long before this was dropped in the advancement of craftsmanship and is therefore no argument in support of the self obliteration of Pottery for another material.

A good design for a freestone building is a bad design for a granite one. A steel casket is different in Artistic possibilities from a gold one. The treatment of English Oak is different to the carving of a soft wood in the hands of the woodcarver and modelling a figure for Bronze is an entirely different proposition to that destined for pottery especially if it is to be finished in high glazes. Cast metal and wrought metal have a character of their own, metal shapes made in clay are fundamentally wrong because they violate the truth, throw away its most precious quality for something that is entirely inferior. It is more difficult to make, more difficult to decorate, more difficult to produce, therefore bad business from a potter's point of view.

Sharp cut edges are characteristic of metal where soft and rounded edges and angles prevail in pottery, both perfectly right in their own sphere, both wholly wrong when changed over. The argument that bronze is even more ductile than clay does not apply to the copying of a Queen Anna teapot in pottery. You can imitate a basket in clay, but it cannot be a work of Art in Ceramics, although it may be a "tour de force" of craftsmanship.

A ferro-concrete building may be ruled off in lines and pretend to be stone, but it is a despicable lie and "There is no hope of progress of the Art of any nation which indulges in vulgar and cheap substitutes for real decoration". (Ruskin).

If clay is not different from granite, I am willing to place my head at Dr. Mellor's disposal. The Art Section of the Ceramic Society could, I have no doubt, help in the matter of the standardising of the names of colours, but at present all their spare time is devoted to the building up of a rational taste for the best in Art, and especially in Ceramic Art.

In quoting Omar Khayyam, the super Egoist, betrays a pessimism which is not at all in accordance with Dr. Mellor's greatness nor with his confessions.
Omar says:

> Myself when young did eagerly frequent
> Doctor and saint; and heard great argument
> About it and about, but evermore
> Came out by the same door, where in I went.

For me; I prefer Wm. Burton's parody:

> I often wonder what the potters buy,
> One half as precious as the stuff they sell.

I must congratulate Mr. Plant on the very able way he has put the case for the manufacturers. Many of the points he raises I have already dealt with, and it is a real difficulty to discover any point we are not in entire agreement upon. He seems to sigh for the good old days when things did not move rapidly (Josiah Wedgwood's days certainly would be a rest cure to Major Wedgwood), I sometimes think they are not quite rapid enough. Style is a thing that takes care of itself. Sincerity is the only sound foundation to work on. Originality or distinction in style is the hall mark and natural evolution of sincere craftsmanship. It is only out of a turbulent age like the present that there springs a living Art. Make the most of the prevailing fashion, but do not palm off base metal on the public for pure gold. A well-drawn pattern will not sell any less than one that is badly drawn. If Mr. Plant will accept that I am satisfied. "The question of price, easy manipulation, and practicability of any given pattern are all factors that skilled designers work upon, to which may be added packing and effective marketing of the goods".

I do not agree with Mr. Plant about the potter following the times. He is usually in the front line and not in the rear of the army. Ideals are never realised. Truth itself is moveable, and more so are ideals. To accomplish anything we must have ideals and remain faithful to them, but a decorator or manufacturer who sinks his ideals is a bad case. There may be and are compromises to be made but *never with a lowering of the standard we strive for*. There is no necessity for pessimism about the future of Art. If we make the most of the present the future will look after itself.

Mr. H. J. Plant:—In answering Mr. Forsyth's criticism of my paper, I am puzzled to know what could have led him to think that I was a lover of "base metal" productions. If this is his opinion, it is as far from the truth as the East is from the West.

The thing I wished to combat was just this—that no particular school has any right to say that this is the correct style of design, and all others, no matter how beautiful they may be, are outcasts.

The patterns I referred to as good sellers, are good sellers, because not only are they well drawn, but have in them considerable artistic merit, although it may not be merit which would meet the approval of a certain school.

In his reply to my paper, when Mr. Forsyth talks about "Well drawn pattern will not sell any less than one that was badly drawn," it seems a little like hitting below the belt, for the simple reason that no badly drawn pattern would be tolerated on our factories. We are not lowering the standard, but we cannot tolerate the futurist school or indeed any other school telling us that this style and this only is beautiful. An artist may for commercial reasons have to produce a range of designs that may not be his ideal type, and yet even these designs may have in them some considerable artistic merit. Hence their ready sale and the object of my paper.

Dr. J. W. Mellor:—I agreed so much with what Mr. Forsyth said in reply to my notes that we must be understanding different things by the same words, or else our logic is different. In a couple of paragraphs in my note I tried to hint how difficult it is to get clear concepts of the meaning of a lot of the language used in Art. I could understand Mr. Forsyth's remarks better had they been made extempore, but he had them prepared some days before, and they presumably represented his considered opinion. Mr. Forsyth is concerned with my being in deep water and proposes to rescue me. I do not know his definition of a parody. His sample is highly inartistic—to me, if you please. With all due respect, all this sort of talk is worth nothing. The *argumentum ad hominem* is poor stuff. It merely represents an attempt to score a point which has no real bearing on the subject at issue. I asked for bread and ye gave me—water.

Mr. Forsyth in claiming that I do not understand the real difference between clay and granite, etc., elaborates a thesis that the artist must adapt his work to the material he is using. I would vote for the latter proposition whole heartedly. Hence, as I have said, there must be some misunderstanding. I think it is easy to see that Mr. Forsyth is needlessly intolerant. If a man complained to his wife that she spent a bit too much money on hats and she retorted that he would not have her go about bare-headed, she might succeed in silencing her husband, but she has not answered his point. I think Mr. Forsyth's reply is as logical; if he will re-read my statement without assuming that I mean something different from what is said, he might possibly admit

that certain shaped teapots or vases, obviously based on metal designs, may be beautiful in themselves; and that the mere fact that they have previously been made of metal, is an historical accident which has nothing to do with their ugliness or beauty. I am further inclined to press this point because he showed an angled vase on the screen without disapproval, and he exhibited a large fluted jar as a specimen of superlative loveliness. Both of these have metal shape written all over them, and yet we are both agreed as to their beauty. This is quite satisfactory evidence that my contention is right, and that Mr. Forsyth is here fighting his own shadow. What on earth is gained by Mr. Forsyth asserting wrongly that I am confusing granite and clay, and then offering to immolate his head if they be not different?

Mr. Forsyth's statement that the craftsman in Art must adapt his art and tools to his material is to me so very obvious that I never raised the question at all. *When, however, Mr. Forsyth claims that plasticity is the peculiar precious quality of clay, and then exhibits a specimen of beautiful art which cannot well be made from clay as a plastic material, but has to be cast like a molten metal, or worked by the inefficient equivalent "pressing," then it is up to him to show that his proposition is not illogical and inconsistent, and that his standard is not wrong per se.* Why deny the casting qualities of clay? Why not apply a few adjectives to this precious quality? It is as marvellous if not more marvellous than plasticity itself.

I hope I am not misunderstood. I am fully in accord with most that has been said on the development of a modern Staffordshire style, but I want it clearly understood that it will be based on our own standards, and may or may not be in accord with the views and standards of others.

Here is a quotation from a recent report on the pottery exhibition at the British Industries Fair:

> "Design has its laws and regulations, that are as inviolable as those of the Medes and Persians. It is wrong—and it is time its futility was recognised—to say that art is an inexact and intangible thing and the plaything of fashion. A design is good, or it is bad, for certain clear and definite reasons, the chief of which is fitness—fitness to the purpose the article is to serve, fitness to the materials out of which it is made, and fitness to the process by which it is fashioned."

This quotation makes a statement about art, and some statements about design. I agree with all that is said about Design except to add that the experts are not always agreed in the application of the principles, but that merely illustrates the fallibility of man. A design, however, may satisfy all these criteria and yet be hopelessly poor Art. I therefore assume that in the second sentence the writer confuses "Art" with "Design," otherwise, let us have these exact and tangible things placed before us for examination. Nothing that I have seen so far has stood analysis.

II.—Symposium on Gas Firing.

INTRODUCTION.

By Dr. E. W. Smith.

IT is my duty to open this discussion on gas firing, but as I am not quite sure whether it is your intention to discuss the question from the broad aspect of the gaseous firing of kilns in general, or whether you wish to treat more particularly with the gaseous firing of a particular type of furnace in which ceramic materials have to be dealt with, I will deal briefly with the former.

It is obvious to everyone that each application of gas to the firing of furnaces needs to be considered entirely on its own merits. It is not possible, for instance, to obtain any figures in regard to costs of thermal units which can be taken as capable of settling any particular question without special consideration being given to a variety of local circumstances—the local cost of fuel and so on. Generally speaking, however, there are three or four industrial gases which, from a thermal point of view are worthy of consideration for industrial purposes. First of all, there is town's gas, with a high calorific value of about 500 B.T.U. gross—which should be nearer 650 B.T.U. if it were really satisfactory straight coal gas. In no case, however, excepting where comparatively small furnaces are in view, or where the works is distinctly small, would town's gas be considered seriously from an industrial point of view on account of cost. If the works were big enough to carry either a blue water gas plant or a producer plant, town's gas would never seriously compete. Although town's gas offers advantages, in that high flame temperatures can be obtained—indeed certain high temperature operations can only be performed by means of town's gas if gas is to be used at all—it is not a gas which seems to require much discussion before the Ceramic Society this morning, since the potters' operations mainly will be conducted on a large scale—a scale such as would render the employment of town's gas unprofitable. The main advantage in town's gas is that the gas is obtained from an outside source, and all the responsibility of the production of the gas is shelved upon the outside source; consequently, there is at once a considerable saving in ground space. The conditions of supply, however, are not in the main what they should be.

The constant calorific value of a town's gas is very important for all heating operations, but there are other factors which are more important still, such as constancy of supply and constancy of pressure. The latter is as important as calorific value. The question of the constancy of specific gravity is another factor which, although overlooked to a very large extent by many gas undertakings, is of great importance, because you will realise that what

the consumer requires is that a constant flow of heat units shall enter the furnace. Although in the first instance it may appear that town's gas will ensure the constancy of conditions which are required in a given furnace, those who have had experience of gas furnaces know that there are many instances where this does not happen. It is not, of course, in all cases that absolute constancy of conditions is necessary. Where big volumes of ware are dealt with, and the radiating surfaces of the furnace are immense, then temporary oscillations in conditions are not so detrimental as when similar conditions operate in smaller furnaces. The prime factor, however, which rules out coal gas for large operations is the large cost of heating units. Latterly the production of town's gas has been considerably modified by the adoption of vertical retorts of a number of types which have made it possible to produce a gas of a better quality from the point of view of heating purposes than has been obtainable in the past. Although the calorific value of the gas is lower, the cost of the gas to the consumer is also lower. There are limits, though, to which this can be taken, and unfortunately, I am afraid many gas engineers have not yet appreciated sufficiently the necessity for avoiding the temptation to increase the production of gas per ton of coal to an extent that is not justified by the B.T.Us. It has been shown by Sir George Beilby and others, that the question of inerts in any gas for heating purposes is a matter of secondary importance, providing that the inerts do not vary. The only circumstances in which inerts do really count are those in which very high temperatures are required. But for all temperatures up to 16-1700 deg. C. moderate inerts are of slight importance. I am speaking now entirely from the point of view of the consumer. To the gas engineer, who has to wash his gas, it is foolish to admit inerts unnecessarily, because of the extra cost that is entailed, but to the consumer the inerts do not really matter.

Blue water gas is another gas which seems to offer attractions to the industrial user. As to whether any given concern should adopt blue water gas in preference to producer gas is largely a matter of the temperature which one desires to obtain without regeneration, as well as of the cost of steam raising, and the cost of coke, which is the only fuel that is usable in a practical way in connection with a blue water gas plant. This particular gas has a calorific value of about 300 B.T.U. gross, and its inerts should not be higher than 8 or 9 per cent. including the CO_2. It costs about 25 per cent. more on a B.T.U. basis than coal gas, principally due to the demand that exists for coke, and the fact that the cost of distribution of blue water gas is equal to that of a gas of a higher calorific value. But if the blue water gas is produced on one's own works, then all the costs of management and costs of distribution are cut out, and the figures that may be presented from time to time in regard to costs have to be corrected if you wish to obtain a true comparison between the costs of producing blue water gas and those entailed

in the making of producer gas or using town's gas from the town mains. To put in one's own blue water gas plant would entail a considerable capital cost, but, with it, great regularity of results can be obtained so far as the production of the gas is concerned, and high temperatures are easily attainable. If steam could be raised on the works at a low cost, this would be all in favour of blue water gas, and if further efficiencies could be embraced in the direction of the utilisation of waste heat from the boilers the cost of production would be still further cheapened. After all, however, the cost per B.T.U. of blue water gas is higher than the cost per B.T.U. of coal gas, and the initial cost of fuel in any firing operation is a matter for serious consideration.

Coming to producer gas, it can be said that the majority of the heating operations pursued in large works generally, and in the refractory materials industry in particular, can be carried out quite conveniently, and with great regularity of results, as well as with fairly easy control, by means of producer gas. In view of the fact that the cost of manufacturing this producer gas on one's own works, as compared with coal gas and blue water gas, is in the relative proportion of 3, 4 and 5, producer gas is by far the cheapest form of heat units in an industrial undertaking. A particular advantage in its use is that one has the opportunity of using a large variety of fuels. One is not confined to coke alone, or to any particular grade of coal, or coke; almost any combustible fuel can be employed, providing it is of reasonably constant quality. Too much is made, I think, in all gas producing operations of the difficulties of working with particular fuels. Gas engineers sometimes say "We cannot make coal gas in this or that particular plant with Durham Coal." But the difficulty is not Durham coal, but in the use of Durham coal mixed with other coals which are different. If you can confine your operations solely to Durham coal, the difficulties in dealing with such a type of coal will be considerably lowered. In the same way with producers. About the middle of the war I had the experience of having to work in an emergency four producers on coke alone. It was an emergency which lasted for 2½ years. The coke that was sent, which was the only type available, was a coke which was the last one in the world that you would have chosen for the purpose—a bad Durham-coal coke. After we had isolated this particular type of coke from the other cokes, and after we had had about 3 months' experience, we found that it was possible, without any difficulty, to obtain, in normal producers and under normal conditions, 120 c.f. of gas to the ton, of 130 B.T.U., with an amount of steam used in the producer which was quite normal—not more than ½ lb. of steam per lb. of fuel gasified. I want to make the point that with producers, whether external producers or generators or internal producers, it is possible to use a great variety of coals, providing only you will restrict yourselves at any particular time to the same type of fuel, and study

the conditions which are necessary for that particular type of fuel.

When you come to the question of considering the adoption of a particular type of gas producer, you have to divide your consideration probably into three sections: first of all, with the fuel that is available will it be better to run under recovery conditions or non-recovery; secondly, will it be better to run with a battery of external producers and allow the gas partially or completely to cool, and use a semi-cold or completely cold gas; or, thirdly, will it pay better to put in a different type of producer altogether under conditions which require a much smaller draught, and use the hot gases direct from the producer? In most industrial operations, where the gas has not to be distributed, and where the application is sufficiently large to put a producer in the setting of the particular furnace, then the internal producer is always the cheapest form of producer to run. With an internal producer, it is possible to obtain a hot gas, with an effective c.v. of between 155-160 B.T.U. per cubic foot. You will save anything up to 20 per cent. of heat by using the hot gas in preference to cold. As regards labour costs, in nine cases out of ten it will pay you to sacrifice a little efficiency in gasification if the costs of running the producer from a labour point of view can be reduced considerably. By the adoption of a step grate clinker troubles will be minimised, but the disadvantage of this lies in the percentage of carbon that is taken out of the grate with the ashes. Of course, the fuel can be picked afterwards, but that naturally entails labour that has been relieved in the clinkering of the furnace in the ordinary way. The step grate itself, however, does help considerably in the reduction of labour in the running, of the producer. Such a step grate has to be of ample dimensions but, if properly designed, will work under a very low pressure from a stack pull. The steam should always be used, whatever the type of producer, if it is only from the point of view of cutting down clinkering troubles. With a step grate, and the use of the steam, clinkering troubles should be of negligible amount. The carbon in the ashes can be used excellently for steam raising.

If coal is used in the producers then recovery plants may be adopted providing the plants are big enough. It is quite a question as to the extent to which recovery plants do pay as compared with non-recovery, because in the former you always lose up to 20 per cent. of the heat that is available in the hot gases and in the thermal value.

The last form of gas that I would like to touch upon is a gas that I think may be made in big quantities in the future both on small and large works, viz.:—a gas obtained from the complete gasification of coal. By complete gasification it is possible to obtain from a ton of fuel about 50 thousand feet of gas of a thermal value of about 360 B.T.U. with inerts of about 6 per cent., including the nitrogen and the CO_2. The plant is as easy to manipulate as a blue water gas plant; and again, you have the facility of being able to

use other coke or coal. If you use coke your B.T.U. will not be quite so high ; if you use coal the inerts are low, but the B.T.U. are high. I do not think it will ever be possible to make gas by means of complete gasification as cheaply as producer gas, and in view of the fact that all industrial operations of any magnitude only require a gas of producer gas quality it is my opinion that producer gas will continue for sometime yet to be the gas that is mainly used. I do not think that, without trespassing on the ground of others who are going to speak, I can say any more just at present, in introducing this subject of the various gases that can be employed for industrial purposes.

DISCUSSION.

Mr. E. M. Myers:—I should like to say how difficult it is to exaggerate the important rôle which we all know is played by heat in every industrial operation. Wherever heat is applied, with the exception of electrical furnaces, we know that heat is occasioned by the combustion of carbon and hydrogen. Therefore, it must be our duty to know how to regulate that particular chemical operation. The importance of the correct application of heat treatment in every industry is almost beyond comprehension, and why this most necessary factor is not more widely controlled is to-day being discussed very freely. The Fuel Research Department of the British Association and the Fuel Research Station which has been organised by the Government at East Greenwich will no doubt do a tremendous amount of work in bringing about that fuel conservation which is so much to be desired. Throughout the whole of industry the question of the correct application of heat and the consumption of fuel lies at the very root of the cost of production. Dr. Smith has already told us of the different kinds of gas that can be used in industrial arts, and it is important to bear in mind that the principle of gas-firing, wherever it is used, involves two important considerations, firstly, the generation of the gas, and secondly, the combustion of it, either to carbon-dioxide alone or to carbon-dioxide plus water vapour. I do not know whether I am "rushing in where angels fear to tread," but I think it can safely be said that gaseous firing can supplant any direct-fired process,and when this is brought about it must necessarily effect economy in fuel, rising in many instances to very high limits; 50 per cent. may, I think, be taken as a fairly safe figure. It is just as easy to obtain with gas-firing an oxidizing or a reducing atmosphere, and when I have spoken to people who are continuously using coal for the firing of pottery kilns, and asked them why the use of gas cannot supplant that direct coal-firing, the usual reply to my question has been that the cost of installing gas-firing is prohibitive. I think that if we were to consider the cost of using coal so wastefully as is the case in connection with direct-fired furnaces, and compare it with the first cost of putting

down a gas-firing furnace, the question of cost would not loom so largely in one's vision. Then again, when using gas for the generation of heat in industry, it is very much easier—I am speaking now from practical experience—to control the working temperature of the furnace than it is with a coal-fired furnace, and I think we are all agreed that accuracy of temperature control is most essential for any heat treatment. Not only that, but it is just as possible to obtain high or low working temperatures with gas-firing, and temperatures of a wider range, than it is when using ordinary solid coal. In addition we must bear in mind the very important fact that our furnaces or kilns must needs have a longer life with gas-firing, owing to the more regular temperature that is obtainable. The metallurgical industry can, I think, safely be said to be one of the largest—if not the largest—consumers of fuel to-day. I am speaking now principally of the manufacture of iron and steel. In the manufacture of iron and steel there are three gases which are used for applying heat treatment. Firstly there is one gas which has not been mentioned this morning—blast furnace gas; secondly, coke oven gas, which, with all due respect to "town-gas" manufacturers is quite equal in calorific value and composition to that gas, and is being used for the same purpose to-day in many parts of the country and of the world; and thirdly, producer gas, about which Dr. Smith has already spoken to us. Now, in addition to the use of these gases, every industrial operation requiring heat treatment must necessarily have a furnace which is specially designed for its particular purpose, and just as it is impossible to fix definitely upon any furnace or kiln that is capable of dealing with every kind of operation, so it is impossible to fix upon any design of furnace that is capable of being operated by any particular kind of gas. The case which I wanted to mention specially was this: sometime ago we at Shelton were using producer gas, with internal producers, for firing a furnace in which the steel from a portion of the rolling mills was reheated preparatory to the final finishing of the material. For this purpose we required something like 1·4 tons of coal per hour to be gasified in these producers, which was equal to feeding coal into the producers to the value of 38 million B.T.Us. per hour. We decided to alter the gas necessary for this particular heat treatment, and for the purpose we slightly modified the furnace so as to burn coke oven gas, having a normal calorific value of 500 B.T.U. per cubic foot net. We found as a result that the number of B.T.U. per hour was now only equivalent to 25 millions, showing a very great economy in fuel. I quite admit that we are happily placed at Shelton to be able to use that particular gas, but the illustration serves to prove that in the utilisation of gasfiring, it is up to every user of fuel to obtain the maximum number of B.T.U. for every pound of fuel that is used, whatever the industrial operation that he is engaged in may be.

It will be seen that even where we were using coal in producers for generating gas to heat steel, we were saving a considerable number of pounds of fuel by giving careful attention to the point at issue. As was pointed out by the previous speaker, it is very necessary that the air for the combustion of the gas shall be fed at as high a temperature as possible to the ignition point, and for that reason the epoch-making discovery of Siemens occasioned a great fillip to the use of gas for firing—I refer to the Siemens generator. To touch upon the question of the specific gravity of gas, Dr. Smith pointed out that this is a very important point, and I quite agree with him, because it was found in utilising producer gas, which has a very much higher specific gravity than coke oven gas, we were able to keep the flame brought about by the combustion of the producer gas directly on the steel blooms in the furnace, whereas, the moment we started to use coke oven gas, which in our particular instance has a specific gravity of ·42, we found that instead of being able to keep the flame on the blooms, the gas tended to rise, and we had to take steps to prevent that rising of the gas. What was done was to bring the air further into the furnace than the point at which the gas was brought in. Another method of overcoming that particular difficulty is to have the air heated up as high as possible, so that it becomes rarified and lighter, and the tendency for the gas to pass through the air is not so great. A further method is by introducing a small spray of tar vapour along with the gas, which increases the specific gravity of the combined mixture.

Coming to furnace efficiencies, Mr. Ridge has given us a very interesting table from which we find that the cost of fuel has a very important bearing upon the cost of the finished article. I think it can safely be said that furnace efficiency is the ratio between the number of B.T.U. used in practice and the calorific value of the fuel that is put into the furnace, and that that ratio should be as low as possible. Whilst not wholly condemning coalfired furnaces, I do not think that it should be possible to allow their use except for temporary reasons, and also in very small instances where the first cost is the principal consideration. It may be that the first cost of a gas-fired furnace is twice that of installing a coal-fired furnace, or even higher, but when we consider the increase in efficiency and the decrease in subsequent maintenance costs, the first charge is more than counterbalanced

To come to the question of coke oven gas, which, in my humble opinion, will be the town's gas of the future, we find that in several places in America coke oven plants have already supplanted gas works, and are supplying gas for domestic purposes and industrial operations even as far as 150 miles from the place where the gas is generated. The utilisation of this gas and the cutting out of gas producers is one of the problems of the iron and steel trade of the future. It is our intention at Shelton to cut out

as many gas producers as possible, and to utilise our blast furnace gas with our coke oven gas, and in this way produce what has beeu spoken of at Skinningrove as a synthetic producer gas.

In conclusion, I would like to say this: that in order that a gas-fired furnace of whatever description may be efficient, there must be accurate control, not only of the gas volume and pressure, but also of the air quantity and pressure, and not only should that control be exercised at the inlet, where combustion takes place, but also be capable of easy control where the products of combustion issue. I think that wherever gas-firing has been adopted the economy effected has surprised most people, and seeing that the need for obtaining as many B.T.U. as possible out of every ounce of coal that we possess is so important for economical manufacture, it is up to everybody not merely to study the question, but apply it wherever possible

Mr. J. Dunnachie:—As a firebrick manufacturer I can testify to the enormous savings which have resulted from the installation of gas-fired kilns in preference to the coal-fired type. It is, of course, very necessary that every manufacturer should carefully consider the particular kind of kiln in which he proposes to use gas, because he is in for considerable trouble if he chooses the wrong type. That is a matter for experience. There is no doubt about it that gas-firing will save 50 per cent. of the fuel that is consumed in a direct-fired kiln, apart from which there is a considerable saving also in labour. Gas-firing makes it possible to centralise the work, and obviates the necessity of distributing fuel to, and ashes from, kilns scattered about. The wear and tear on a gas-fired kiln is also considerably less than in the case of a coal-fired one. In the construction of a gas kiln one must be careful to see that a type of kiln is chosen which is not wasteful in the consumption of gas. Some kilns are constructed with flame walls, but this, I maintain, is a waste of gas, because you are depriving yourself of the very best of your heat by muffling it off, especially if your goods are of such a type that they can withstand a direct fire. For goods such as firebricks, a kiln of that description shows, I think, faulty construction. There is a danger of gas kilns being too elaborate and complicated in the way of flues and dampers. There is no doubt about it that the most satisfactory kiln is the one which will give uniform burning with the maximum simplicity. One needs to decide upon a kiln which is free from complications—one which a kiln-man will understand, and one which is as near fool-proof as possible. These are points which experience alone will teach. Without entering in the discussion further, I would like to testify to the fact that, from a good many years' actual practice, it is our experience that there is no comparison whatever between the cost of production or the quality of output of fireclay products when burned with gas, as compared with coal.

Mr. S. T. Wilson:—Gas firing is more convenient than solid

fuel firing for recuperation or regeneration, processes which prevent the most serious losses of heat. By regeneration it is possible to take the heat from the waste gases and fired goods or pass the waste gases through other goods until they are cooled from 100 to 150°C., whereas in firing without recuperation the gases leave the oven at the temperature of the firing goods. This from start to finish is calculated to average about 800°C. When we consider that the temperature of combustion ranges at full firing from about 1400° without to 1700°C. with recuperation we can see at a glance the great saving that can be effected by the use of recuperation.

1400° is decreased to 800° by using cold air.
1700° ,, ,, 150° ,, air and gas at 800°C.

The saving in fuel is more than these figures shew because the specific heats of the gases rise with rise of temperature.

Although this shews a great saving in fuel it must also be shewn that we can attain the desired results, viz.: properly fired goods. In this district we can get these properly fired goods with solid fuel in our wasteful old-fashioned round ovens where less than 2% of the heat evolved from the fuel is in the ware when it is fired and not above 10% when the saggars are included.

The chief essential difference between solid and gaseous fuel firing is that in the solid fuel firing the gases evolved vary in composition from the time the coal is put on the hot mouths until it is burned away ready for another charge. In the case of gas-firing the composition is nearly constant.

This difference seriously affects our methods of firing. Let us examine the old-fashioned fireman's method of getting an equal temperature without discoloring his ware with reduction. Dr. Mellor has shewn that the waste gases from a china biscuit oven contain from 46 to 54% of air in excess of that required for complete combustion. I have shown that if at least 40% excess air is not given we get discolored ware. About 50% is about an average for all the old-fashioned ovens.

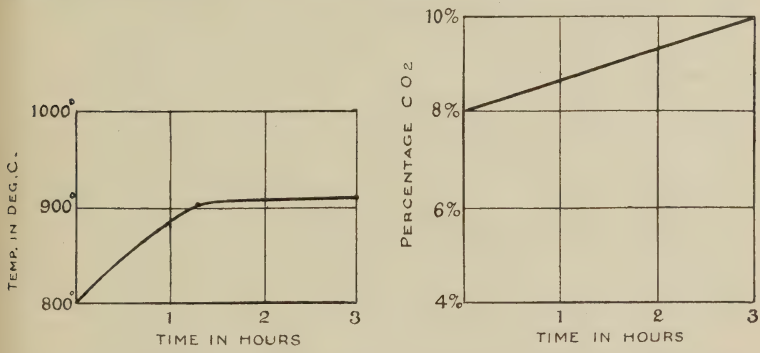
Suppose that the preliminary drying is accomplished and that the combined water is given off from the goods in the oven and that we are at the period of full firing and that the firemouths have just been charged with coal. The mouths are now acting as simple gas producers and secondary air is given through the air regulator doors. These doors are gradually closed as the volatile matters diminish. When they are all driven off we have a period when the fixed carbon is burning. During this period, there is no flame showing in the combustion chamber although the combustion chamber keeps its color *i.e.*, it does not cool and is much hotter than the saggers of goods behind it. No more coal is added until the combustion chamber slightly cools or changes color.

Now, if we were to charge the mouths with coal before this period occurred, or if we kept the mouths filled with coal (by adding fuel to keep the mouths full) we should be gas-firing with

cold secondary air. Past experience tells the fireman what will happen if we do this.

The goods would be discolored. There would be a great difference in temperature. The green saggars on the top of the oven would be blistered with iron and probably (especially in our highest temperature ovens), the bungs of saggars would collapse.

In the normal method of solid fuel firing the two stages, *i.e.*, (1) when the volatiles are driven off; (2) when the fixed carbon is being burnt, enable us to equalise the temperature and keep the ware the proper color. I think the two graphs shew this.



Rise of temperature and amount of CO_2 in waste gases during the period a charge of coal is burnt off the mouths in ordinary solid fuel fired oven. Temperature taken 3 feet above top of combustion chamber.

When the volatile matter is being driven off and burnt with secondary air the temperature just above the combustion chamber rises very quickly while there is more air and less CO_2 in the waste gases. When the fixed carbon is being burnt there is less air and more CO_2; therefore, while heat is being put into the oven that point about the combustion chamber is not rising in temperature. Thus the temperature inside the oven is being equalized. Also in this second stage combustion is complete in the firemouth and the excess air is available for oxidation, whereas in the 1st stage the air and gas are not mixed intimately, hence the long flame which reaches to the top of the oven, and although there is more air, reduction takes place just over the combustion chamber because the combustible gases impinge upon the saggars and the air impinges on the oven wall at this point. Long experience has taught the fireman and oven-builder that a certain depth of fire mouths carefully attended to gives the desired results and he sticks to these methods.

As it takes a considerable amount of energy to convert solid into gaseous fuel, it is not desirable to use gas and cold air. Gas is only advantageous with recuperation—therefore let us examine the effect of recuperation.

When we use hot air for burning the combustible gases we increase the temperature of combustion or the flame temperature is higher. We have already seen that we dare not allow the gases to be burnt with cold air for a long period without unequal temperatures, so if we use hot air with a higher temperature flame this trouble would be accentuated.

For these reasons I have come to the conclusion that for goods that require an oxidising fire and equal temperature, gas-firing can only be safely adopted where the gases are completely burnt in the combustion chamber or where the gases are so intimately mixed as to produce surface combustion, and if they are burnt in the combustion chamber then they will lose their heat very quickly as they travel across the oven. For this reason the oven must have a very small cross-sectional area, too small for a man to work in but large enough for a tunnel oven.

Where the goods to be fired are not injured by contact with the combustible gases or air then gas can be safely used with recuperation because streams of gas and air can be placed at such an angle that combustion will take place all along its path across the oven and so one end of the flame can be made as hot as the other and consequently an even temperature can be produced. Large chamber ovens can be used in this case.

Mr. Richmond:—Possibly the best way in which I can take part in this discussion would be to give a brief outline of our Firm's experience of burning fireclay material in a Gas Fired Kiln. Our kiln was erected in 1914, and has since that date been in regular commission. It is of the continuous type, and is nominally divided into twenty-two chambers. Width of tunnel is 9 feet, height to crown of Arch 7 feet 6 inches—average chamber capacity 7000—3-in. standard Firebrick.

The hot air flue in kiln centre is 3 feet 6 inches to crown of Arch. The air for combustion is drawn direct through finished Brick, and for drying, by a series of dampers connecting with hot air Flue. The kiln is usually burned round in 19 to 23 days the time varying according to class of material being burned. The Gas Producer is of ordinary fixed grate type and measures 9 feet by 6 feet. The main Gas Flue 3 feet runs round the whole length of the kiln, the service flues measuring 18-in. by 9-in. The distance between service flues permits of two double dykes of standard Bricks and the candle ports are four per flue. Perforated Candles 5-inch square and approximately 16-in. high are used reaching to a height of 6 feet 9 inches in centre and 4 feet 6 inches at sides. The fuel used is Washed Treble Nuts giving on Analysis 11,750 cubic feet of 21 Candle Power Gas per ton. Our reasons for using this somewhat high grade fuel are, that a better length of flame and cleaner gas is secured, and consequently less trouble is met with in flues.

The class of goods usually burned consists of all standard

sizes of Firebricks, hollow and solid special shapes up to approximately 2½ cubic feet content. Blocks exceeding this we usually burn in our Newcastle Kilns. The finishing temperature of our Clay which contains a somewhat high percentage of Alumina lies between cones 12 and 13. When burned to this temperature, the after contraction, as proved by a very extended series of tests, is well under the maxium specified in the Gas Engineers' Standard Specification.

In regard to the advantages of Gas Firing, they may be roughly grouped under the following heads:—

1.—*Labour Saving*. To deal with burning the output of our kiln as at present, we require only three men each working eight hours shift, whereas for a similar ouptut with Newcastle Kilns, at least another man would require to be provided for one shift to wheel coal to and ashes from the Kilns. In addition the kiln is erected in such a position in regard to stoves and loading banks that considerable saving is effected.

2.—*Control of Temperature*. The heat at any given point in the burning and pre-heating zones is at all times under perfect and simple control, with the result that uniformity of burning is made easily possible.

3.—The uniformity of burning reduces waste to a very low figure, and under or over-burned material is practically non-existent.

4.—And by no means the least important advantage is that our experience has amply proved that fuel costs for burning amount to less than one half of the cost of burning the same classes of goods to the same temperature in Newcastle Kilns.

The kiln is by no means foolproof, and at all times requires careful supervision to secure the best results, but as the same may be said of any type of kiln this can scarcely be in any way reckoned a disadvantage.

The uniform appearance of the products drawn from the kiln is in their favour, and so firmly are we convinced that, for our class of material Gas Firing is the correct and most economical procedure, it is already decided that any future extensions of our kiln accommodation will follow broadly the same lines.

In 1914 a similar design of kiln was in use at Crook, the fuel consumption of which was stated to be only 5 cwts. of Coke Breeze per equivalent of one thousand 2½-in. Standard Brick

Mr. Wm. Bayliss:—My experience of gas-firing has been mainly obtained in connection with the production of steam, and therefore, except for the experience associated with the actual combustion of gas I have no direct knowledge of the use of gas in connection with the burning of pottery products. In view, however, of the eulogistic remarks which have been passed with

respect to the use of gas-firing generally, I should like to give a little warning note that the production of steam in connection with the generation of electrical energy is most cheaply carried out by direct coal-firing rather than by gas-firing, and this is confirmed in a report of the Nitrogen Products Committee, which report deals very exhaustively with the cost of producing electrical energy by every known method, and I would recommend any of you gentlemen who are interested in this subject to obtain a copy of the report mentioned, and feel sure that the perusal of same will be of considerable interest.

With regard to the subject of gas-firing for pottery purposes, I am of opinion that the desirable temperatures for the proper treatment of these wares can be obtained by the use of ordinary producer gas, and may at the same time say that producer gas is the cheapest and most easily obtainable gas from the distillation of coal.

It has been pointed out by several speakers (and needs no further support from me) that all variations of temperature, as well as all characters of temperature, can be obtained when gas-firing is adopted. There is one special point in connection with the use of gas which the previous speakers have not dealt with, and which, in my opinion, is an important one; that is, that in the use of gas for the firing of kilns the gas producer itself, with all its incidental coal and ash problems, the dust and dirt arising from the handling of the coal and ash, can be so far removed from the actual pottery kiln as to eliminate any risk of dust and dirt contaminating the actual pottery under treatment. Further, the gas producers can be located in the most desirable position with a view to reducing to a minimum the cost of handling the coal and ash. This, of itself, with the present high cost of wages is a matter of no small moment. Further, there is no doubt that the use of gas will practically eliminate the smoke nuisance. I am certainly interested to learn that the successful burning of pottery requires such an oxidising flame as is represented by 100% of excess air, but cannot understand why this is so, unless it has some particular reference to the special products which are to be treated. If 100% excess air is necessary irrespective of the method of firing, *i.e.*, coal or gas, then the economy table which Mr. Ridge has given us can only have reference to the CO_2 associated with the 100% excess air.

Respecting the particular ovens used in the pottery industry, viz: the Biscuit Oven, Glost Oven, the Kilns, and so on—my experience suggests, with all due respect to Mr. Wilson's remarks, that there would be no difficulty in the application of gas-firing to these ovens and kilns. I appreciate fully his points with regard to the difficulty of having saggars in close proximity to the point where combustion takes place, but one must have in mind that when dealing with gaseous fuel its application is capable of great

flexibility, that you can apply it at as many points as you desire, and thereby obtain an even zone of temperature throughout the oven or kiln in use. Further, a system of CO_2 and temperature-recording instruments, can be located in some desirable position, and leads from these instruments can be connected to any number of points in the kiln, enabling readings to be taken readily of the conditions actually obtaining throughout the kiln, such readings giving that desirable information which will enable any necessary adjustments to be made either with respect to the temperatures or the oxidising character of the flame.

Mr. J. H. Marlow:—I am afraid that after all that has been said I feel like a ship becalmed. We have had so much "gas" this morning, and have heard so much about gas, that it seems to have taken all the wind out of my sails. But I shall take a slightly different line than the majority of the previous speakers, and shall concentrate on what I believe will be the best for this particular industry and the district in which we live. I refer to tunnel firing. In 1895, I took up this study in the United States, tackling it from the point of view of natural gas. From the start I made a certain amount of headway, though incidentally I met with many difficulties. My first production was a system of tunnel which had chambers; I found, however, that these chambers would have to be made of refractory material of a very thin "skimpy" kind, and that there was always the fear of the material fracturing, and causing endless trouble. After a number of years, I took up the study of muffle firing, placing in the centre of the tunnel a muffle similar to what we all know as the muffle kiln to-day. I found then that I could use refractory material of a stouter kind. But I still encountered many difficulties; I found that I could get a temperature of 1050° C. fairly easily, but that after that it was a fight all the way, and that whenever I met with a slight reverse in the flow of the gas, the heat failed, and there was a tremendous struggle to get back to the higher temperature. For the past four or five years I have been working up to the point of gaseous firing direct, disposing with the chambers entirely, and using a tunnel composed of ordinary firebricks, without any specially intricate bricks or tiles, by which means I can get far greater stability of construction than I could possibly get from any other form of tunnel construction.

There are three important points which have been touched upon this morning, and which cover the whole field in regard to this system of tunnel firing. The first is that the producer must be right. The second is that the recuperation of the air must be as nearly perfect as possible and under as perfect control as possible. The third is that the exhaust end must be as nearly perfect as human ingenuity can make it. I would like to say that I have devised a producer which I think will meet with the approval of all the gentlemen who have entered into this discussion, and who are

so well versed in the construction of gas producers, and I had hoped that by this time I should have had my direct gas-fired tunnel running. I have, however, been held up by the non-arrival of some castings. Within a fortnight from now I hope to be able to prove to these gentlemen present, and to demonstrate to the entire district, that a direct-fired gas tunnel oven is the coming oven for the pottery ware in which we are all locally so much interested. I have been able to fire in this oven, with equal success, hard paste porcelain, a white vitreous floor tile body, and an ordinary stoneware; in fact, I have been able to get whatever heat is required for the different wares that are made in pottery. In conclusion, I would say that after many years' study of the question of fuel economy I am convinced that there is nothing more to do than for us to put our backs into this question of gas-firing, which will and must become the firing system of the future, at all events so far as pottery is concerned.

Col. C. W. Thomas:—There are one or two points in connection with which I would like to differ to some extent from some of the previous speakers. The main point that has been advanced in the discussion has been that producer-gas-fired kilns are much more economical in fuel consumption than any other type. I have not had any actual experience in regard to gas-firing as applied to firebrick manufacture. What experience I have had has been gained in other directions. I can, however, give you some particulars of the effect of a properly-applied, continuous kiln, direct-coal-fired, which I think will compare quite favourably with any of the figures that can be given for gas-firing. The main point which must have occurred to many of you during the remarks of a number of the previous speakers is that, in practically every case, the gaseous-fired kiln or furnace is always accompanied by recuperation or regeneration, and that it is in that respect that the economy arises. It is not so much in the change from solid to gaseous fuel that economy is realised as in the method by which the regenerative system of firing is carried out. For some years now I have had in use an ordinary 28-chamber continuous kiln, coal-fired, burning ordinary firebrick sizes up to 3 or 4 inches thick, to a temperature of Cone 9 down; the fuel used has been the ordinary fuel of the South Staffordshire district, in the form of small nuts. The waste gases have been taken to the chimney at a temperature of from 150 to 200 deg. C., and the consumption of fuel has varied between 2·2 and 1·8 cwts. to the ton of fired material. I have not yet seen any figures for gas-firing which have been lower than those. I consider that some of the previous speakers have missed some of the valuable features of gas-firing in that they have not insisted as much as they ought to have done on the possible saving in labour. I do not think you can hope—given the same conditions of firing in both cases, and assuming that these conditions are the best that can be applied—for any very considerable economy from the

point of view of fuel, by the mere change from solid to gaseous fuel. In either case, whether it be gaseous so solid firing, if you use regeneration, and apply the waste gases to the heating of the on-coming chambers, or if you use the waste hot air from the cooling chambers for preheating less advanced ones, or take that hot air away for use in a dryer, you get practically the same economy. But obviously in a gas-fired kiln, particularly a gas-fired *continuous* kiln, where you can have all your producer plant on one spot, you can arrange mechanical contrivances for handling your fuel and for taking away the ash and clinker from the producers, and by this means you can reduce the number of men employed on a plant of given output—providing it is big enough—and can so effect very considerable economies from other points of view than the mere aspect of fuel consumption. From the point of view of fuel economy I think every kiln in which the waste gases are allowed to go to the chimney at anything over 150 or 200 deg. C. is sheer waste; but you can get as much economy as that I have quoted by the adoption of a properly-designed continuous kiln, whatever the type of fuel may be that you employ in it.

One other point. A good deal has been said of the importance of an absolutely uniform supply of gas and an absolutely uniform temperature. Of course, in a gas-fired kiln you naturally have that supply of fuel rather more under control, but I doubt very much whether this is of so much importance in the burning of refractories as it is in certain other industrial processes. You are bound to get slight variations, but I do not think it effects refractories to anything like the same extent as it would the goods that are fired in a metallurgical furnace. Everybody I think, sooner or later, will have to come, if not to gaseous-firing, to recuperative or regenerative firing. Of that I do not think there can be any question. For my own part, any further extensions to kiln plant that I may contemplate will undoubtedly be of the continuous type, and probably gasfired, for the reasons I have stated, that the gas-fired kiln offers greater economies in labour, a much lower repair bill—so far as my own personal observations go—and, generally speaking, it enables one to lay out one's plant to better advantage. I noticed in Mr. Richmond's paper, read by Mr. Leckie, a reference was made to one of the economies resulting from the better lay-out of the plant, but obviously this is not an economy that is specific to a gas-fired kiln, since you can lay out your plant better from a labour and administrative point of view, whatever the type of kiln may be.

One fundamental point it is necessary to recognise at the outset of any discussion on gas-firing, and that is, that whatever the kiln or furnace may be which you are going to erect, the type of the structure itself, and the general lay-out, is always modified by one's own local conditions. The old saying as to putting new cloth into old garments applies with full force to a firebrick works.

There is, in my opinion, only one satisfactory way of modernising an old firebrick works, and that is to pull the whole place down and build a new one on the site.

Mr. C. W. Speirs:—I wish to compliment the author on his paper. I have never heard such a big subject dealt with so concisely. With regard to the question of the application of gas-firing to a particular industry, I think every industrial enterprise must look out for itself. Professor Armstrong said that when you leave college the first thing to do is to find out what is being done, and when you really know what is the practice, then you can begin to apply your technical knowledge to the facts as you find them. If I were speaking this evening instead of this afternoon, after going round some of the pottery kilns which I hope to see this afternoon, I might be able to say a little more on the subject. In my own experience all that you have been talking about is perfectly obvious. The difficulty is that all your works are more or less old, and the only really satisfactory way to make a good job of them would be to clear them out and put up new ones in their place. That, however, is not practical politics. You can only employ the knowledge you have in the direction of applying it to new portions of your works as the occasion arises. With regard to the economy of gas versus coal, in my own opinion it is simply the continuous plant that is the good plant. Of the two I should say that the coal-fired kiln is really the most economical in fuel, but that is not the only point. The percentage of good goods produced is the crucial test. On the other hand, the gas-fired kiln has much to say for itself from the point of view of ease of regulation, and therefore, the uniformity of its products should be greater than with the coal-fired furnace. During the war I had the opportunity of putting into practical use an idea that I have had ever since I joined my firm. Our work is of a rather difficult character, and the main point was this: the muffle containing my goods, which have a rather large carbon content, needs a reducing atmosphere. We have to bring these carbonaceous goods up to a temperature of anything from 800 to 1,200 degrees C. We employ muffles 16 feet long, 10 feet high, and 4 feet 6 in. diameter. We can get these goods brought up to the requisite temperature perfectly uniformly, within a hundred degrees anyhow, at any part of the kiln, which I may say is of the regenerative type. Directly these carbonaceous goods are burned to their required temperature cold air comes round the muffle. Not a particle of carbonaceous matter is burned inside the kiln. This has never been done before, I think. There is no reason, so far as I can see, why your pottery goods should not be burned in the same way by gas in a continuous type of kiln. There are one or two other points of interest. The kiln has a ferro-concrete case, in order to keep it air-tight. I do not think that without a lot of experience you can realise how important it is to keep the

whole structure air-tight. In the majority of constructions little leakages are continually occurring. The provision of the ferro-concrete case, however, has overcome all the difficulties; it has been running now from 2½ to 3 years, and I will defy anyone looking at it to imagine it has been running more than 2 or 3 months. It is practically in the same condition now as when it was installed.

SIR W. J. JONES:—We have already exceeded the limits of time set out on the agenda for the discussion of this subject, and therefore we must now bring the discussion to a close. But before calling upon Dr. Smith to reply, may I express my own personal pleasure upon his having come here, and started this discussion. I feel that whether gas-firing, or any other form of firing, is ultimately proved to be the best, after careful consideration of the various local conditions—which conditions must of necessity vary—at any rate the discussion will have had the effect of causing most of us to ponder the point as to whether or not some improvement and economy is not possible in each individual case in which we may happen to be personally interested. If I may say so, I think that the exponents of gas-firing have had a field day, and have put their case forward pretty strongly. This should cause the advocates of straight coal firing to reflect as to whether, in any extensions or improvements which they may contemplate, the question of gas-firing is not an exceedingly important one. We have had testimony from those who have been working gas-fired kilns for a long period that they themselves are more than satisfied with the results, and that they claim an economy of 50 per cent. or more over the methods previously used. Having regard to the fact that the fuel consumption in the fireclay industry is something over 2¼ million tons per annum, any economy which even approximates to a fraction of 50 per cent. is a matter of national interest. What I would myself like to suggest, if it is agreeable to the other members of the society, is that this discussion, which does not seem to me by any means to have exhausted the subject, may be adjourned until our next meeting in the winter. I think that by that time a large number of the members of the society may have reflected upon the possibilities of different forms of firing, and may be in a better position in the course of a few months to give us the advantage of their views, whereas they may not feel themselves capable of doing so at this particular juncture.

DR. SMITH:—There are, I think, one or two points which might be accentuated in the winding-up of the discussion. Col. Thomas hit the nail on the head when he specially brought up the necessity for looking thoroughly into the figures that may be presented of possible economies. When a particular individual says "By adopting gas-firing I have saved 75 per cent. of my fuel," this does not necessarily mean that a similar economy will be applicable to any and every other undertaking which, at the

present time, may be using a direct-fired furnace under the best possible conditions. I quite agree with one of the speakers who stated that he believed that the direct-fired kiln, from the fuel point of view, can be just as efficient as, if not more efficient than, a gas-fired kiln; but this is not the whole point. The question is, what is the over-all efficiency from the point of view of economy, results and output? Fuel is only one of the factors. When you consider all these three points I think you will agree, if you start *de novo*, or you are able to alter your arrangements, that there is no doubt about gaseous firing being the only possible method of heating kilns efficiently and in the proper way. In Birmingham gaseous firing, in the metallurgical industry, has extended as much probably as anywhere, and quite a large bulk of gas—probably up to 25 per cent. of 10,000,000,000 feet of coal gas per annum is being used for metal smelting and annealing, which has gladdened the hearts of those gentlemen serving on the Smoke Abatement Committee, as well as all others interested in the question of smoke reduction. At Southampton the Government rolling mills ran the whole of their plant on gas, no solid fuel being used whatsoever, either in their huge muffles or in their 250 metal smelting furnaces. From reports which I have seen from the metallurgical societies, the products compared favourably with any metal that has been turned out by the best undertakings in the country producing strip metal rollings. The product was good, the costs of production low, and in every way gaseous firing was satisfactory. Just to dispel one point of misapprehension that may have arisen, Mr. Foster, in referring to direct firing, all through his remarks referred to gaseous firing with internal producers, *i.e.*, with the producer right up to the job you are about to heat; gaseous firing all the time in direct contact with the furnace, not direct-fired coal in the furnace.

The only other point that I wished to bring out is, that those who are going into the question of direct-firing will have to consider the proposition not from what they have heard in detail of the results of other people, but by comparing their own results, their own conditions, their own possibilities, with the guarantee of known results from gaseous firing. Do not assume that because certain conditions are attainable in some other connection they can be applied, necessarily, absolutely and in detail, to your own particular concern. Every proposition requires consideration on its own merits, under its own conditions—locally and technically. It is only by that means that you will get down to a working balance sheet. Fuel conservation from the point of view of your own particular industry is not the only consideration, nor perhaps even the most important.

III.—Some Unsolved Problems in Potting.

PRESIDENTIAL ADDRESS.

MAY I commence my address this evening by congratulating you all very heartily on the successful work of the Session, so rapidly drawing to a close. I feel sure you will agree with me when I say that the papers which have been contributed have well maintained the high standard set in previous years and have afforded each of us much useful matter for careful thought and further investigation, whilst the discussions that have followed have been both helpful, instructive and at times entertaining.

To-night, however, I do not wish to dwell at any length upon the many successes I think we can fairly claim our Society has achieved (great though these have been), for I would remind you that this year we attain our majority, and doubtless it will be the wish of all our members that that auspicious occasion shall be celebrated in a way worthy of its merits. Then, possibly, it may fall to my lot as President, or to that of some other member to review the many ways in which this Ceramic Society, from the days of its earliest infancy until now has placed the whole Potting World under a debt of deep gratitude as a result of its investigations, and when that opportunity comes I have no doubt but that all of us will be surprised to realise the great help which the Society has given to the Ceramic Industry in solving some, at any rate, of its many difficult problems.

My object to-night, however, is rather to direct your attention to the other side of the question, and to endeavour to remind you that although much has been accomplished, and many problems solved, still there remain many great problems calling for our investigation and solution, and numbers of difficulties to be overcome and so I would assure you of an almost unlimited scope for your endeavours and deliberations in the future, and urge that as nothing succeeds like success, the motto of our Society should ever be "Excelsior."

I regret that personally, I cannot claim to have a specialised knowledge of any particular branch of our great Pottery Industry—for the last 25 years or more my endeavours as a Master Potter have been directed towards the organization of the many Departments which go to make up the modern Earthenware Factory, and ensuring their working together harmoniously in the production of goods such as would command a ready sale in the markets of the world and thus provide full and satisfactory employment year by year for an ever increasing number of workers, whilst of course, at the same time always aiming to have some small surplus of profit left at the end of each twelve months' trading to compensate

my partner and myself for the personal labours we have put in, the many risks we have undertaken, and the capital we have employed—consequently I have had practically no time to do any original research work personally.

The one fact, however, which has always impressed me is the number of difficulties which are ever popping up in the manufacture of Pottery, and so to-night I ask you to accompany me in thought on a short trip round our Cobridge Works, and as we pass rapidly from department to department, I would in simple language endeavour to call your attention to difficulties we meet with and suggest possible improvements that could, I believe, profitably engage your attention in the future, and as these difficulties and problems are by no means confined to ourselves, but common to many in the trade, your help in solving the problems and overcoming the difficulties and investigating the suggested improvements would prove, I am sure, a boon to many engaged in the industry.

Saggar Making. As we enter the works the first department is that of the Saggarmaker. Often as I have stood watching the laborious work of the frame filler and bottom knocker, it has struck me that our present methods are very out of date, and that surely some simple machine could be contrived that would perform these processes more efficiently and economically than can be accomplished by manual labour. Again I look forward to the time when a saggarmaking machine much more satisfactory than anything at present known shall become installed in each works.

As I examine my records of the average life of the saggars used, I am amazed by the extraordinary amount of wastage in this branch, and I feel sure that this Society can help materially in producing saggars whose weight shall be considerably less than those at present in vogue, whilst at the same time their durability shall be increased at least four fold and thus confer a benefit upon worker and manufacturer alike.

Surely it is not an extravagant flight of my imagination to anticipate the day when the normal average life of a saggar shall be 100 firings—instead of shall I say 10 to 15 as to-day.

May I here pay my tribute to the value of the experimental work in marl mixing in which Major Moore is engaged at Messrs. Wedgwood & Sons' Works, Etruria, and express the hope that his efforts may reap the reward they so richly deserve, and that very shortly he may be able to give to the trade a recipe for marl mixing that may bring this hope I have ventured to suggest much nearer its fulfilment than it is to-day.

I am one of those Manufacturers who would very much like to see the Saggarmaking Committee of the B.P.M.F., under the leadership of its enthusiastic Chairman and stimulated by the valuable advice of its experts, provide locally in each Pottery centre an up-to-date and fully equipped marl mixing plant which would enable

each Manufacturer to obtain there prepared marl of a very much superior quality than any he can produce under present conditions on his own Factory—this I venture to think would materially reduce the cost of pottery production.

Mill and Slip House. The next department we visit is the important one of the Mill and Slip House. Here let me say that I believe the future of British Pottery in the markets of the world depends largely upon its quality, even more than upon its price. As a nation we cannot hope to compete in price with the Asiatic races whose workers could not only exist, but actually thrive upon an economical rice diet, hence it is vitally essential to the success of our industry that we should obtain the very finest materials we possibly can for each process and especially for such important factors as our bodies and glazes.

I believe my experience is by no means an unique one when I tell you that during the war period, and since, I have submitted samples of ground flints to the Pottery Laboratory which upon analysis have given less than 90% of Silica, I have handled trials of china stone which when fired at the usual hard earthenware bisque fire have proved so lacking in fusibility that they have at first sight been pronounced flints by practical potters; ball clays have been used in the Potteries which have been absolutely wanting in that vital property of a good ball clay—plasticity—and even good brands of china clays have on firing exhibited a decidedly yellow shade, which whilst very artistic and fashionable as an on glaze decoration, brings despair to the heart of the potter who is aiming for a high-class white semi-porcelain body.

Now whilst I sympathize with the many handicaps I know my friends the Materialists have had to encounter during these recent difficult times, may I appeal to them personally, as to those who are directly concerned in the future success of our great industry, to do all that care, supervision and enterprise can jointly accomplish in providing the potters of this country with materials that are regularly, not intermittently, in every sense of the word of "A1" quality.

Turning again to the Slip House, I would like to ask whether you are not in agreement with me when I say that I believe the future will bring us better methods of preparing clays than any in use to-day. It seems to me that it ought not to be beyond the engineering skill of this district to suggest an improvement on the present style of pumps used in pressing up our clay bodies. I cannot help but think that the intermittent stroke of our present pumps must cause an unnecessary amount of wear and tear upon both filter cloths and presses, and if some method of compression could be devised by which the pressure could be maintained steadily and continuously, not only time but wear and tear would be saved in the filtration processes. I leave this for your consideration.

Grinding. I am aware of the profitable discussions that

have taken place at the meetings of this Society from time to time with regard to the relative merits of cylinder and pan grinding methods, but do not think this subject has been by any means exhausted yet. Personally I am sure it would be of immense value to the trade were this Society to gather together all the data with regard to the maximum efficiency obtainable in cylinder grinding—give all information with regard to the various sizes of cylinders commonly in use in the trade, shewing for each of such :

(1) The h.p. that is required to drive same.
(2) The number of revolutions advised for speed of travel.
(3) The weight of the flint pebbles necessary for efficient grinding.
(4) The thickness of lining advised.
(5) The weight of the charge best suited for each size cylinder.
(6) The quantity of water necessary, stating whether to be supplied at one or two periods during the grinding process.
(7) The necessary time that would be required to grind to a given definite fineness each class of material.

Were the information thus obtained circulated throughout the trade, or say amongst the members of this Society, each cylinder grinder would compare his results with the maximum efficiency data as supplied by the Society and would naturally endeavour to bring the efficiency of his cylinders nearer to that shewn as the maximum possibility, and thus the whole district would benefit.

I was much impressed when discussing this subject of cylinder grinding with our old friend and fellow member Mr. Max Odelberg, during his last visit, by the really wonderful results he was obtaining on his Swedish Factory—much better I should say than any obtained locally, so far as my information goes. Surely then here is a process which by the investigation of this Society can be considerably improved.

Boiler and Power House. Leaving the Slip House we shall probably pass a load of fine black powder on its way to the boiler hole. This powder is nowadays designated by the local collieries as engine slack. You and I can well remember the day when it would have been more correctly described as duff, or dust, or smitham, or some similar name. My aim in mentioning this is to point out the danger of any gust of wind carrying these fine black particles into the various making departments, and thus destroying some of their efficiency and to suggest that it may be possible in the future to fire economically our pottery boilers either by gas, or perhaps following the lead of H.M. Navy, by oil, and were this done how much cleaner and therefore more efficient our works would become.

Mould Making. Passing on into the mould-making shops one asks oneself is it not possible to obtain a plaster which shall make our moulds much more durable than they are to-day, or on the other hand, is it too much to hope that some day we shall discover

a method of satisfactorily recovering for further use the slotch or waste plaster so evident in this process.

Potters' Shops. As we enter the potting departments one is bound to admit that here the human element is all important and powerful, and one is tempted sometimes to say if only each present-day potter would take a personal pride in every article he was producing, and be as ashamed of turning out a bad piece as he would be of doing a dishonourable action, the quality of English pottery would take a great upward leap and the life of the Clay Manager would become almost a bed of roses. Can any member of this Society suggest any way of obtaining this desirable result? If so, he will indeed be a public benefactor and well worthy of having his name engraved in gold in an honours list of the members of our Ceramic Society.

Looking round the clay departments I would suggest that some member would be doing good service by making an investigation into the respective merits of the casting and jollying process of making various articles such as say jugs, coverdishes, toilet basins, dishes, or teapots, having regard to :—

(1) Quality.
(2) Speed of production and therefore output from worker.
(3) Actual cost.

Personally, though I am entirely wanting in any mechanical genius, I have often thought there is great possibility for an automatic casting machine for such articles as tea cups, or similar pieces which have to be produced on a massed scale. In this machine slip could be automatically weighed, moulds filled, moved on, dried, emptied of surplus slip, dried again to enable the clay piece to be emptied free from the mould, the pieces then moved, conveyed on a belt to the spongers, who would fettle them whilst the mould would be carried on through a further drier and returned once more to the point of commencement for a further filling and succession of processes which could all be automatically carried out.

I wonder whether any member of a mechanical turn of mind could work out a machine such as I suggest, for if carried out to success, I am convinced that in this way costs could be tremendously reduced and quality improved.

Bisque Ovens. Leaving the clay shops and entering the bisque oven department, it is not my intention to say much to-night about oven firing, having regard to the very valuable work which is being done by the Oven Committee of the Federation and to the many enterprising efforts being made by several firms in connection with continuous gas firing ovens of various types, some of which will doubtless overcome many of the difficulties so common to our old type of pottery ovens. As, however, there must be many years of valuable work yet to be done on factories still retaining the old type of bisque ovens, I do suggest that this Society could do a very helpful service to firemen, managers and manufacturers alike

by editing a simple pamphlet on bisque firing in homely and clearly understandable language, shewing how such faults as specked ware, crooked ware, flashed ware and spit-out ware are occasioned, giving hints as to best methods of avoiding such errors and stating clearly the critical temperatures in the process where additional care has to be maintained, and also giving some simple comparison tables of the amount of fuel required and time actually necessary to raise given weights of the various classes of goods to definite temperatures.

I am sure a simple pamphlet of this description, compiling the result of many years of investigation on the subject by members of the Society would be of untold value in the hands of the more intelligent of our managers and firemen, and would materially help to reduce avoidable losses in bisque firing. Possibly the Society may be prepared to consider a suggestion of this description.

Bisque Warehouse. Turning to the Bisque Warehouse, I feel sure that additional consideration might be given to the question of improved methods of making good faults as shewn in the Bisque Warehouse occasioned by errors either in the Slip House, by the potter, the placer, or the fireman, and thus many a piece which to-day finds its way to swell the loss bench might be promoted by a little extra care and attention to the ranks of first grade goods without in any way impairing that essential quality of good selection.

Printing Shops.—We next visit the Machine Printing Shop. Here I look forward to the day when we shall be able to print underglaze by machinery in two or more colours as satisfactory as we do in one to-day.

May I next discuss with you the important subject of underglaze colours. Here I maintain there are vast possibilities of improvement and investigation. How much easier the work of the printed order getter up would become were pinks possible which were not so susceptible to the effects of the glost oven fire, and which would yield an equally regular and satisfactory result whether placed in the third ring or arches—if apple green still remained apple green under all conditions instead of wanting to become at times olive green or even some darker member of the great green family—if matt blues never shewed any tendency to frizzle or run with the glaze, or if the members of the cobalt clan and their many near relatives, such as the Cantons and the Peacocks never displayed any inclination to wander from the correct positions set out for them by the designer in his scheme of ornamentation when overcome by a slight overdose of glaze or an unusual sharp touch at the hands of the glost fireman. In fact, if underglaze colours generally had a greater margin of safety the difficulties of the potter would be considerably decreased.

Dipping House. Then as I glance at the dipper I wonder when it will be possible to profit by the many failures of the past and at last succeed in introducing a dipping machine so perfect that even

in this process a great step forward may be made and as in the Tile trade the human dipper may be saved from his dangerous employment and the mechanical one reign supreme in his place.

Glost Placing. So far as Glost Placing is concerned, I do not think that any member would be willing to agree that the last word had been said and that no improvement could be suggested in our present methods, not to speak of the possibility of newer and more efficient systems being introduced.

Decorating. As we approach our decorating shops I would suggest that we in common with many other manufacturers look forward and anticipate many improvements from the labours and endeavours of the members of the daughter Society the "Art Section," so far as general design and decoration are concerned, but we would gladly welcome any suggestions our own members can make with a view to introducing a size for lithography which could be gilded upon without any defects becoming apparent in the gilt decoration—many firms of size makers have at times claimed to have solved this question; but so far as our experience has gone none has been able to justify that claim up to the present.

Mechanical Transport. Before we complete our trip may I say one word about the problem of mechanical transport on the works generally. Prior to the war, I believe I am correct in stating, very little attention had been paid to this subject on many of our local Factories—during the war, however, and since, much more consideration has been given to it and many firms are installing conveyors, runways, elevators, etc., with a view to expediting output, saving labour and reducing losses—more attention, however, should be given to this subject, with I am sure beneficial results, and probably many members of this Society could make valuable suggestions.

Avoidable Losses. My last point of all I consider the most important, that of the reduction of the many avoidable losses and leakages which occur on almost every Factory. Some firms I believe do not make any strict analysis of the pieces made and paid for at the clay end and compare same with the exact quantity of these same pieces which are sent out from the Packing Department, and thus cannot ascertain the exact percentage of loss or leakage during say a period of twelve months.

For several years we have done this and I regret to say that the very best result we have ever been able to obtain for any twelve months has never shewn less than 16% leakage and sometimes even heavier. That is one piece out of every six at least gets broken or disappears in passing through the works and of the remaining five that reach the packing house a considerable proportion are seconds and thirds, so that the percentage of best pieces is even further decreased. Possibly some member may consider the figures I give unusually heavy. May I suggest to such that on their works they should take 100 or 100 dozen of cups of a special

shape, at the clay end, and allow same to travel through the works in the usual way, without any special precautions and finally reach the packing warehouse. I feel sure whoever does this will discover that the loss is greater than he has any idea of.

I know you will agree with me that it is the duty of every manufacturer and manager to give every facility possible on the works with a view to reducing these losses, and still more is it the duty of every worker to exhibit every care with the same aim in view.

If there is one warning I should like to see posted up in large letters in every department of the works it is the words "TAKE CARE"—want of care more than want of knowledge is the greatest fault we suffer from to-day. The problem is how to instil into all our workers such a spirit that it would come naturally to them to use every piece they handle as though it were their own. Additional supervision, bonuses, payment by results have all been tried, but still there is something lacking. Is it possible for some of my hearers to suggest methods which would help to solve this, the greatest of all our pottery problems? I hope so.

Ere I sit down may I express the pleasure it has been to me to preside at your Monthly Meetings and also tender my personal thanks to your Secretary, Assistant Secretary and all the Members of the Committee for the generous support and unfailing courtesy I have received at their hands. I have always had a very great opinion of the value of the work of the Ceramic Society, and that good opinion has been both confirmed and strengthened by the Meetings we have held during the past Session. Whatever therefore, either during the short time I still occupy your Presidential Chair, or later when again I resume my position as a private member, I can do to further the interests of the Society I shall gladly and readily undertake.

I need scarcely remind you that you and I as potters are members of one of the most ancient, the most beautiful, the most interesting and at the same time the most useful of all the ancient crafts. To us as English Potters, our predecessors have bequeathed a wonderful heritage. It behoves us therefore to see that we pass on to those who shall succeed us that same heritage at least unimpaired, but I trust also improved, as a result of our efforts, and in the accomplishment of this I am sure the work of our Ceramic Society will be of untold value.

IV.—Further Recent Improvements in Swedish Potteries.

LECTURE BY A. S. W. ODELBERG.

(REPORTED BY H. TOWNSEND.)

MR. Odelberg explained at the outset of the lecture, that the first of his two films, entitled, "From the Clay to the Cup," was produced with the view of giving the general public an insight into the various processes incidental to pottery manufacture. The aim of the cinematograph company producing it was to obtain a series of such films, of real educational value, and of as interesting a nature as possible, taken from many industries, and embodying short interspersed descriptions of the various processes dealt with, in order to create a taste for something better than the trash that is unfortunately all too frequently shown in the picture houses. The company's request to film his factory was readily acceded to, and after he had seen the result he thought it might be of interest not only to show this particular film to his English friends, but also a further one, more technical, illustrating the new machinery of which he had something special to say on the occasion of his last appearance before the society. Naturally, this second film was of no interest to the general public, and was not intended to be shown to them. It had been decided to preserve both films for the benefit of later generations, on the same lines as some of their pottery productions were preserved from time to time as a record of the factory's development extending over about a hundred years.

The first film shown by the lecturer commenced with a general view of Gustafsberg, taking into purview the factory and the harbour, wherein a steamer was discharging English china clay from Fowey. It was explained by the lecturer that as china clay is not found in his own country, it necessarily had to be imported. The steamers left Sweden with a cargo of timber and returned with a cargo of china clay. Views of the sliphouse machinery followed, showing the crushing arrangements for the quartz and felspar, as well as an edge runner crushing the grog that is used in the making of the saggars. For thirty years the factory has utilised cylinder grinders, which were filmed in operation. These are driven by individual motors. It was seen that the clay is hoisted to the top of the sliphouse, and gradually works its way down to the pug mill in the cellar, which was also photographed in operation. A view of the potter's wheel came next, and the projecting apparatus was purposely slowed down in order to show the remarkable way in which the continuous camera can portray every separate move-

ment of the human hand.

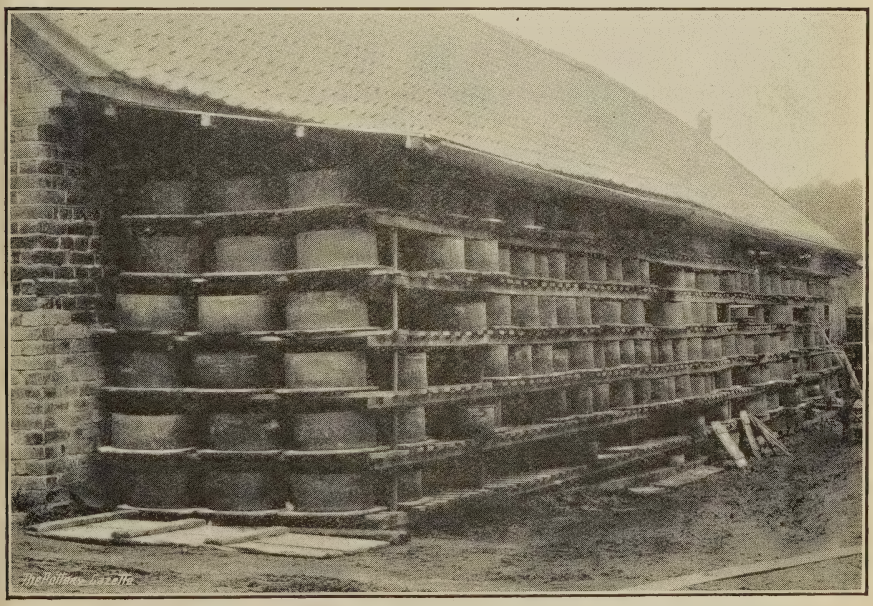
A section of the film which was of peculiar interest to many potters present was the making of oval dishes and an oval soup tureen on the jolley. The lecturer explained that they have been jolleying oval ware for the past eighteen years. A plate-maker was photographed in the act of making bone china plates on the jolly in the same way as earthenware flat is produced in the Staffordshire Potteries. The casting of fancy ware came next; then cup-making and handling, in the latter case the cinematograph emphasising the careful and skilful movement of the hand in the process. The "sticking up" of vases with an applied ornamentation was equally interesting. Then followed a view of the biscuit oven, showing how the saggars are piled up from floor to crown; and a photograph of one of the fire mouths. Mr. Odelberg explained that his biscuit ovens were fired two-thirds with coal and one-third with wood. The same ultimate result could be obtained with wood as with coal, but the cost of labour was greater. An underglaze printer, working at an electrically-heated stove, was next in order of routine; a one-colour roller printing machine followed; then a three-colour printing machine; and afterwards a view of the actual transferring of the tissue prints to the biscuit ware. It was indicated how the printed biscuit ware, before being sent to the glost oven, was "hardened on," after which the ware was placed in iron baskets and transported by electrical conveyors to the tunnel oven. Views of the glost ovens and the electrical transporters were particularly interesting, it being clearly shown how the conveyor brings the ware from the glost oven to the glost warehouse—where the sorting is done—how the saggars are emptied by the girl sorters, and how the empty saggars afterwards travel back on the conveyor to the placers, who are ready to receive them and replace them.

Views of the decorating shops took into account the entire hand painting on a plate, and the subsequent firing of this in the enamel kiln was indicated. It was emphasised that the kiln bats are of fireclay, and in this detail are unlike those generally used in Staffordshire, which are constructed of iron. The rearing of plates in the placing of the kiln was also remarked upon. An amusing incident occurred in connection with the filming of the placing of the kiln. The placer was unfortunate enough to drop one of the plates, whereupon the audience tittered. "You may be interested to know," interjected the lecturer, "that that plate did not break. I am sorry that the film did not take in the whole of its fall, so that you could have seen that for yourselves." It was shown how the finished wares are afterwards packed in wood wool, made by the firm themselves in the precincts of their own sawmill, and enclosed in wooden boxes and cases, which are also made to the last nail by automatic machinery.

The second and more technical film dealt rather more precisely with the somewhat novel process of manufacturing square, flat,

and hollow-ware by jolley and jigger. The production of a square soup tureen by this method, as well as of a square toilet basin, were watched with much interest, Mr. Odelberg meanwhile explaining very clearly the particular action of the jigger head, which imparts the square contour to the revolving piece of ware. A German lithographic transfer machine, which has been in use at the factory for eighteen years, was seen automatically dusting the colours on the transfer sheets. An electrically-driven stilt-making machine, fitted with six dies, and operated by a woman, was photographed in the act of turning out from 6,000 to 7,000 stilts in a working day of eight hours.

In a word or two with regard to electrical energy, the lecturer remarked: "As you know, we have driven our factory by electricity for quite a considerable time now, this electricity having been generated by steam power. We are now going to connect the factory with the great trunk lines from the north of Sweden. The current will be brought down to the factory at a voltage of 25,000, and we are building a tower which is going to contain the transformer by means of which the current will be transformed down to 500 volts. We hope to switch up this new tower house by January next, and by means of it we are hoping to be able to reduce the cost of the electrical unit, which now costs us the high price (?) of from 2d. to 2½d. per unit, to about ½d. per unit."



View of rough saggar shed.

Commenting upon the difference of the climate on the Baltic shores from that experienced in England, Mr. Odelberg showed an interesting view of a rough saggar shed, which was erected sometime ago for the purpose of enabling them to make, during a glorious but short summer, and to dry by the hot rays of the sun, a reserve stock of saggars. In this way the saggars, he said, dried thoroughly within two or three days—far better than they could be dried during the winter by steam generated at a high cost. This shed, a photograph of which is here reproduced, Mr. Odelberg described as "going back to olden times," his idea, no doubt, being to contrast this rough-and-ready, but eminently practical, arrangement with the ultra-modern electrical conveniences to which he had just previously been referring.

The concluding portion of the film showed the delightful setting of Gustafsberg on the timbered shores of the Baltic, the extremely picturesque location of the workmen's cottages, exterior and interior views of which were shown, and a view of a stream of apparently very contented workpeople leaving the factory gates at mid-day.

After the exhibition of the two cinematograph films and a number of supplementary slides, Mr. Odelberg gave some authentic information with regard to the advantages which had attended the installation of the electrical conveyors about which he spoke at some length a year ago. He said that in order to show the saving in labour, both in the placing and drawing of biscuit and glost ovens by this method, it was interesting to be able to record that whereas, in 1917, *without conveyors*, the working hours per oven (for placing and drawing) were 675 and 600 respectively for biscuit and glost, the figures to-day *with conveyors*, were now 460 and 425 respectively, which was equal to a saving, roughly, of 30 per cent. in labour in both cases. Not only was there this important saving in handling, and a consequent greater output from the plant, but there was distinctly less breakage, owing to the decreased amount of handling entailed.

"I want again to draw your attention," said Mr. Odelberg in conclusion, "to the arrangement, at a right angle with the potters' stoves, of the bench at which the platemaker works, and also to our premium system of payment, which has resulted in a greatly increased output, and has brought benefits to the workmen and the firm alike. For instance, a certain platemaker, during a month of 27 working days, including five Saturdays, made a total of 31,360 8-inch plates, or nearly 1,300 per full working day. Since January 1st, our working week has been reduced to 48 hours, and approximately we have in this manner been able to maintain our full output without increasing the number of our hands. The factory, as a whole, I am glad to say, has not only maintained, but has greatly increased, the output during the past few months, as compared with the former longer working week, this having been

largely due to better organisation and improvements of our labour-saving machinery, as well as to an excellent understanding between employers and workpeople."

DISCUSSION.

Mr. ASHLEY MYOTT:—I think that after such an interesting lecture as that to which we have been listening this evening we shall all appreciate that in Mr. Odelberg we have not only a master potter but a master engineer. One of the chief features of the lecture, which must have appealed to each one of us, will have been the record of the way in which engineering and labour-saving devices have found their place in Mr. Odelberg's factory. There will no doubt be numerous questions which you will wish to ask the lecturer. I will begin by asking one from the chair. I do not quite understand what material the wheel was made of that is used for the grooving of the insulators.

Mr. ODELBERG:—It is made of felt. I described it last year, and it was a source of great pleasure to me to hear from a member this evening that a similar one has been installed at his works and is working very satisfactorily.

Mr. T. SIMPSON:—For how long is the biscuit oven fired with wood?

Mr. ODELBERG:—The same as with coal. About 70 hours. It makes very little difference whether we fire with wood or with coal when we fire in the way that I described last year. We get the same temperature all over, and the time occupied is pretty much the same. The only thing that is objectionable about wood is that it requires very much more labour to convey the wood from the ships in the harbour to the particular point at which it is required on the works. Even when the wood is deposited at the oven it requires very much more labour to throw it into the fire mouths. I sincerely hope that the output of coal in England will shortly be very much increased, so that we can revert to our old practice of getting our coals from Blythe in Northumberland. We shall much prefer that method.

Dr. BEAVIS:—Mr. Odelberg has spoken about wood firing. I think I am right in saying that the calorific value of wood as compared with coal is roughly 1 to $2\frac{1}{2}$, the B.T.U. of ordinary coal being about 13000, compared with about 5000 for wood; consequently I imagine that one would need somewhat more than $2\frac{1}{2}$ tons of wood to replace a ton of coal. Is that Mr. Odelberg's experience?

Mr. ODELBERG:—I cannot say exactly, for the reason that the wood is sold in cubic metres, whereas the coal is sold by weight.

I believe that 3·6 cubic metres of wood corresponds to about 600 kilos of coal, which is roughly a little over ½ ton of coal. The reason I mention these particular figures is because they come readily to me. The old Swedish way of selling wood was to offer it in parcels of 6′ long, 6′ high and 3′ broad, equal to 3·6 cubic metres. That quantity corresponds in heat value to about 600 kilos of coal. The price to-day at Gustafsberg of 3·6 metres of wood, is something above 100/-, whereas the coal works out roughly at 200/-. You will see, therefore, that whilst we are saving something in first cost by using wood, we lose it again in the additional labour that is entailed. There is a further point to consider, and that is that our wood supply is, to a certain extent, limited, and it is economically unsound to use wood for firing purposes when it is possible to get so much more for it by selling it to the paper pulp manufacturers.

Mr. A. Leese:—Is there as much smoke escaping from the crown of the oven when firing with wood as with coal? In our present-day methods of firing with coal there is uudoubtedly a tremendous waste in that respect. I should imagine that one would get a better composition of heating gases in the oven when using wood, that the smoke and gases that are evolved by the wood are not largely in excess of what is required for combustion, and that consequently a more even combustion would be secured.

Mr. Odelberg:—In answer to that I would say that in our experience it makes very little difference. If one fires by the direct-fired method, as we do, the supply of air that is required for combustion is set according to the indicator which shows the analysis of the oven gases. An oxidizing flame is required just as much with wood as with coal. There seems to me to be no hope of saving anything in that respect. Wood is rather nicer to fire than coal; on the other hand wood has rather a nasty habit of making a very long flame—too long. The tendency is with wood to scorch the saggars, and to give a rather more reducing flame than is preferred. The result is that the saggars become very much more discoloured. and experience has proved that the life of them is not so long. The iron in the saggar crystallises out, and the life of the saggar is shortened. That is our experience. The life of the saggars was very much longer when we fired with coal alone, than it now is when we fire with coal and wood mixed or with coal alone.

Mr. L. D. Lovatt:—I understand that Mr. Odelberg makes a certain amount of bone china. Has he ever had any reports of green or brown china when firing with wood?

Mr. Odelberg:—I may say that we have never used wood-firing alone for china biscuit. We have always saved our coal for that purpose. The reason for that is that the china biscuit ovens are not constructed on the same lines as the general earthenware ovens, which are bigger and can be better regulated, for the reasons

that I gave last year. The china biscuit oven is the one with its own chimney stack, and with flues in the walls, something on the lines of the Minton downdraught oven. In this instance we do not find it to be any advantage at all to use wood.

Mr. C. E. Ramsden:—The discussion seems to have turned into a bye-lane. It appears to me that although it is no doubt extremely interesting to compare the results of wood-firing with those of coal-firing, it is not at all likely that in our time it will be necessary to commence cutting down the trees at Trentham in order to fire the potters' ovens in this district. I think it might be more advantageous to turn the discussion upon the very excellent mechanical appliances which Mr. Odelberg has called to our notice. One point in regard to which I would like a little explanation is Mr. Odelberg's statement that he did not make any saving in labour except in the drawing of the ovens. Are we to infer from this that no use can be made of the mechanical conveyor with which the ovens are circuited except for conveying the saggars full of ware ?

Mr. Odelberg:—Yes ; that is just it. We do not use the conveyor except for the drawing of the ovens. It is practically of no use for the placing. The saggars, when they return from the warehouse, are taken off just near to the bench where the man is engaged in refilling them. That is just close to the door of each oven. The ovens are all placed in a long row—biscuit and glost. The placers stand in a row. When we are drawing an oven the saggars, filled with ware, travel by means of the conveyor through the warehouse, where they are emptied by girls. The saggars travel back empty, and are taken off just at the right point where they are wanted for refilling. Then again, there is always a little vibration on the conveyor, and you know how sensitive the unfired ware is. I am afraid it would be out of the question to use it for conveying the placed ware.

Dr. J. W. Mellor:—I understand from Mr. Odelberg that he grinds his raw material in the cylinder about 7½ hours. In this district we usually occupy a much longer time than that. Mr. Odelberg and I have discussed this before, but I am sure many would like some information as to the percentage and degree of the fineness of the material after it has undergone seven hours grinding.

Mr. Odelberg:—The information which Dr. Mellor asks for was given in a paper which I read at Stoke in 1905. The cylinders which you saw rotating in the first film are the identical cylinders that were then being used. They run at about 30 revolutions per minute, which we find to be a most advantageous speed. In 1910, I gave some further particulars as to the boulders used. These are never specially selected boulders such as are recommended. Every time we recharge the cylinder we add about a bagful of new stones, about 2″ in size. In due time all the pebbles grind

off, and the material from the pebble goes into the flint or the felspar. That makes no difference. Our experience is that the cylinder does not grind well until it has run about 18 months, for the reason that there are all sorts of pebbles—large and small. We used to crush the flint by means of edge runners. We do not do that now. We simply pass the calcined flint through an ordinary stone breaker, set fairly fine. When the flints are not more than ½″ in size they are placed in the cylinders; water is added—and of course the proportion of dry material to water must be the right proportion. I do not quite remember, but I think that after about half the time more water is added. By this time you are dealing with much more fine material, and it grinds very warm. At the finishing point, just before we take out the charge, the material is steaming. As to fineness, I think I gave you some figures last year. Our quartz we grind for about 8 hours. The surface factors of ground materials were mentioned about 16 years ago in a book by Mr. W. Jackson. 2128 is the surface factor for quartz as we grind. A friend of mine was kind enough to send me some years ago some samples of English slop flint ground by the old English method of pan grinding. On comparison I found that I get very much finer particles by cylinder grinding. Surface factor of mentioned samples of English slop flint was 1771. Felspar (uncalcined), simply crushed and added to the mill, and ground for 10 hours, gives a surface factor of 2949. Vide page 43 Transactions of the Ceramic Society Vol. XIX., 1919-20.

Mr. G. Blair:—Can Mr. Odelberg tell us what particular lawn the ground material will pass?

Mr. Odelberg:—Yes; it will pass easily a 120's or 130's lawn. The majority of the material would, I think, pass a 180's. As most of those gentlemen present will realise, it is not advantageous to grind too fine. It is necessary to find out which particular degree of fineness best suits the type of body you are making. That is why the system of testing, which I advocated last year, by means of the Schöne apparatus, is found to be very handy.

Mr. A. E. Gray:—I notice in one of the films, which Mr. Odelberg exhibited, that a number of decorators were working at individual benches. Is that adopted as a principle at the Gustafsberg Pottery, and is it found to be an advantage in the decorating departments? In our factories the decorators, for the most part, work at one long table.

Mr. Odelberg:—The hand-painters in the decorating shop all work at one table. The little bench which was seen in the film was simply one of a series of supplementary benches which are provided for each girl in order to receive the ware prior to and after she had dealt with it. That is the general method in the painting department. In the transferring department the printers usually

work two and two, with one cutter between them, stationed at a separate bench. The washing off is done in a current of water near by.

Mr. J. GIMSON:—May I ask if the rotary thimble machine is Mr. Odelberg's own invention, or one that is on the market ?

Mr. ODELBERG:—It is my own invention. We have also patented the three-colour printing machine and the square-dish-making-machine.

Mr. W. EMERY:—Has Mr. Odelberg found it possible, as a result of the revelations made by the continuous camera, to speed up the operations of the thrower or the jollier ?

Mr. ODELBERG:—That is a question that is quite new to me. The operation as you saw it in the film was purposely slowed down, so as to enable one to analyse the movements. I do not think there is very much possibility of speeding up the thrower or the jollier by any such method as that suggested.

V.—Question Box I.

1.—*Question* (1a)—How is it that certain trials of *hard-fired* biscuit earthenware have crazed more readily than the same body when *easy-fired*?

Mr. F. Turner :—I think that without a kind of buffer layer between the body and the glaze, you are liable to crazing even where their coefficients of expansion agree fairly well. As to hard-fired ware crazing, whereas easier-fired does not, most people making vitreous bodies have experienced that frequently, and it will have been the experience of many that very quickly fired glost ware crazes more readily than slowly fired. Does not that look as though it may be a question of the glaze taking up sufficient of the body to alter the composition of the glaze in immediate contact with the body to some extent, with the creation of a layer of equilibrium between body and glaze? I would like to suggest that the hard-fired trials of Mr. Bishop be repeated, and fired for glost in the biscuit oven. I think he will then possibly find that with a longer firing he will not encounter so much crazing. I do not suggest, of course, that this is a commercial solution of the problem, but merely an informative experiment.

Mr. A. G. Richardson :—This question is certainly an important one to potters. I am in perfect agreement with Mr. Turner in the view that the inter-layer between the body and the glaze is a very important factor. Quick glost firing may have something to do with it, but I do not think this would account for very much in this case. By giving the ware a longer firing in the Glost oven it would certainly tend to obviate the crazing. Keeping in mind what Mr. Turner has said, I think it is just possible that the glost ovens, for that particular glaze, are not fired sufficiently long to enable the interlayer to develop far enough, that is to say, the glaze has not eaten sufficient of the body to form an inter-layer which is really safe.

Mr. B. J. Allen :—I would like to raise the question as to whether crazing does not take place more readily on an easy-fired biscuit than on a hard-fired biscuit. Taking sanitary ware, for instance, if you have easy-fired biscuit ware you nearly always have crazing ; if, on the contrary, you have hard-fired biscuit, you do not get crazing.

Mr. D. F. W. Bishop, M.A.:—I may say that I was the originator of the first question. Mr. Allen is, of course, only voicing what has been in the minds of all of us, viz. :—that hard-fired biscuit

ware—whether it is sanitary, general earthenware or majolica—should be much less liable to crazing than easy-fired. But I can only give you some facts that we have ascertained at our works during the past few months. We have made a number of trials, and the curious point is this ; if you take those pieces fired at 33 or 36 Bullers' rings, and with an ordinary white glaze upon them, it will be found that they have crazed much more readily than those fired eight to ten points less on the rings. This is a result that we have repeated a good many times. One explanation of it supplied by Mr. Jones, of Newton Abbot, as applying to majolica, is that the glaze takes up more silica to satisfy itself. I should be inclined to think that if this is true of majolica it may quite equally be true of an ordinary white earthenware glaze when put upon an ordinary white earthenware body. This was one explanation that had already occurred to us. But it is a fact that ware fired to point 26 on Buller's rings has crazed very much less readily than the same ware fired to point 36. Although this is quite contrary to one's usual experience, the fact remains that this phenomenon has been encountered, and consequently I considered it a good question to bring up for discussion this evening.

Mr. B. J. Moore :—It seems to me that the natural thing to do under the circumstances would be to make a glaze that is more liable to craze on an easy-fired than on a hard-fired piece.

Mr. Bishop :—But it is impracticable to have a different glaze to suit each five points on the scale.

Mr. Moore :—My point is that if you were to reverse the order of your glaze, making it more liable to craze on easy-fired ware than on hard-fired ware there would be a bigger margin of safety. It would seem that the glaze is lacking in some way and that it takes up what it needs from the easy-fired ware, forming a correct glaze on the easy-fired ware, whereas it is not liable to take up what it needs from the hard fired ware, and consequently crazes.

Mr. Bishop:—Personally, I think the reason is chiefly that given by Mr. Jones. I brought the question forward not really as a manufacturing difficulty, but as an academic point requiring investigation, thinking that it might be of interest to members of the Society to hear of certain trials we have made.

Mr. B. J. Allen :—Again referring to sanitary earthenware. I have pieces of the same body and glaze, some that are crazed and some that are not crazed. I have satisfied myself that there are two conditions which operate to cause the crazing. One of these is where the glaze on easy-fired biscuit attacks the body to an undue extent ; such cases are easily tracable under the microscope. The other condition is where the glaze is applied unusually heavily. In both these cases the actual amount of glaze taken up by the

biscuit piece is considerably greater in the case of easy-fired ware than in the case of hard-fired ware. Wherever we come across a very heavily glazed piece we always expect crazing ; also where the glaze attacks the body to a greater extent than normally, crazing inevitably results.

Mr. R. H. H. Jones :—In reply to the first question as to why certain tiles of hard fired biscuit craze more readily than the same body easy-fired, we have come across this experience altogether apart from our Dressler Kiln in the manufacture of tiles. We noted repeatedly that if we fired as we did from time to time a few clay tiles in our ordinary majolica kiln instead of in the biscuit oven, invariably the tiles were less liable to craze than tiles fired in the ordinary biscuit oven, and we often find as our experience of the Dressler that tiles are much less liable to craze when slightly underfired than is the case when tiles are even very slightly over fired, the crazing becoming worse the harder fired the tiles may be. The writer accounts for this phenomenon by the suggestion that the glaze is able to satisfy its need of silica more readily from the easy-fired than from the hard-fired tiles and the desired stability of the glaze on the body is the better realised.

Question (1b)—Presuming that a quick biscuit fire only penetrated "skin deep" into a thick piece of ware, would the glaze respond to the interior or the exterior of the body in the matter of crazing or peeling?

Mr. R. H. H. Jones :—With regard to this question we are afraid we have no experience by which we can be guided to an expression of opinion, but should be tempted to think that the exterior of the body would be more likely to be the determining factor in the matter of crazing or peeling.

Mr. B. J. Moore :—So far as I can see the result is due to the type of glaze employed, and if we were to carry the thing to an extreme, say by taking a tile and glazing it with nothing but red lead, it is perfectly certain that the hard-fired tile would be more likely to craze than would the easier-fired tile. The tiles fired in the majolica kiln presumably have a soft glaze, which is dependent upon the body for a good deal of its silica ; therefore it will balance itself more readily on the easy-fired biscuit than upon the harder fired biscuit.

Mr. A. G. Richardson :—The basis of crazing or non-crazing is due to the lack of agreement of the coefficient of expansion of body and glaze. Working from that standpoint we get an answer to Mr. Bishop's question. He states that he gets non-crazing at a certain temperature, and then with harder firing he gets crazing.

Well, just at the point where he gets no crazing, that is the point at which he must get this comparative agreement of the coefficient of expansion of both body and glaze.

Mr. Bishop :—What I said was that one was *more liable* to get crazing at the higher temperature.

Mr. Richardson :—At any rate the liability of crazing is less at the lower temperature. Possibly the higher temperature to which he refers is rather too high for the type of glaze which he employs, or, in other words, that the glaze has not sufficient latitude for expansion. In glost firing you are bound to work up and down somewhat. Certain glazes will stand up to these variations, although they are removed from the exact point at which the agreement of the coefficient of expansion of the body and the glaze occurs. I am rather inclined to think that Mr. Bishop's glaze is too far removed from the point of agreement, and that the fault might be more readily removed by a slight adjustment of the glaze than by attempting to bring about a more equivalent coefficient of expansion in the body itself. Of course, Mr. Bishop knows his own body and glaze, and it will be well-known to him that certain substances will work in certain directions. I would suggest that he works on that basis. The answer that Mr. Jones gives is perfectly right. When he gets the ware from the Dressler it is on the easier side, and he encounters less crazing than in the case of the harder fired ware which comes from the ordinary oven. In this case it is more likely that the body, being porous, permits the glaze to attack more of the body, taking up more of the alumina and silica or whatever other substances are attackable in the body, which would, in consequence, alter the coefficient of expansion of the glaze. This would correct the fault, not accidentally, but on a scientific basis. This, to my mind, is much better than adding a little more or less of this or that by guesswork, or firing easier or harder. Most pottery bodies have a certain margin in both directions. I should be disposed to think that in this case the margin is too narrow, and that it would be advisable to alter the glaze rather than interfere with the firing. The amount of alteration necessary may only be small, and I would suggest that this is the best way out of the difficulty.

Mr. C. D. Grimwade:—If testimony is required in regard to tunnel ovens, I am able to say, from a short experience of biscuit firing in a Dressler oven, that if the earthenware is overfired in point of time or temperature it is very liable to craze after a normal glost fire. This leads me to the second part of the question. It has been frequently stated that the quick firing of a tunnel oven only gives a flash fire to the biscuit—in other words, does not soak it properly. At first I thought that was the cause of some crazing which appeared, but a *reduced* firing temperature proved to be the remedy. In

short, then, both underfired and overfired biscuit earthenware requires a glost fire of abnormal time or temperature to ward off subsequent crazing.

Mr. A. Heath :—Last year Mr. Leese and I did some work together on an earthenware body, and although it was not an ordinary body the same point came up. All the hard-fired pieces crazed, whilst the easy-fired pieces did not. I think Mr. Jones is quite right, viz. :—that it is due to the glaze taking up silica from the body. A state of equilibrium is necessary between the body and the glaze. This you do not get in the case of the hard-fired ware, for the reason that the glaze cannot penetrate into the biscuit body. I think it is quite right scientifically that easy-fired ware should not craze. We have, I know, always been accustomed to the reverse idea, but I am of the opinion that we have always been wrong. Of course, it depends somewhat on the nature of the glaze. You could easily make a glaze that would not craze on the hard-fired ware.

Mr. Bishop :—But in our case the pieces were treated under apparently identical conditions. There must be some limit of elasticity between the body and the glaze, and it seemed to me that this would be a very interesting problem for the Society or the pottery students to work upon. If you go on firing ware at ring 26 or 20 or even lower, some point must be reached where the easy-fired ware would craze very much more readily than would the ware fired to ring 36. The point that it seems necessary to decide is, how much silica does the glaze take up in order to be saturated or to satisfy itself, and what is the point on the Bullers' ring, or any other heat recorder, below which you get more crazing on account of easy firing? There is a parallel in regard to the bone in china, which, up to a certain point, acts as a flux, but beyond that point exerts a reverse action.

Mr. A. Heath :—I would like to raise the question as to whether in a vitreous body it is thought that the flint acts in its natural state, or as it would in a porcelain body. In a vitreous body I think you get the flint acting rather more as it would in a glaze, that is, as a flux.

Mr. A. G. Richardson :—I have not had much experience with vitreous bodies, but I do know that in the case of semi-porcelain and ivory earthenware bodies it has been proved at numerous factories that finer ground flint leads to dunting and splintering, and that even in the mere sorting of the ware a sharp knock with the sorting tool has been sufficient to cause it to splinter and crack very readily. This has not been an uncommon experience in the Potteries. The fault may be readily distinguished from crazing, although sometimes it has the outward appearance of crazing. With a crazed piece—and by that I mean a piece that has crazed

from the ordinary causes of crazing—if you strike it with a sorting tool or a hammer, you cannot get, with reasonable knocking, any splintering, whereas with a piece that looks crazed but is really dunted or splintered through over-ground flint, shattering occurs in nearly every case as a result of the blow. I am convinced that over-ground flint in an ordinary earthenware body is very dangerous, and that no flint should be ground past a certain point. That point I am not able to specify, but I can give you my opinion. If you grind flint to such an extent that it will pass very readily through a 250's lawn you are looking for trouble. If, however, you grind the flint so that you will have a slight residue left on a 250's lawn you will be fairly safe in a semi-porcelain or ivory earthenware body. If the flint is ground finer than that it adds a little to the plasticity and also a little to the contraction. These two things are not in themselves very important, unless you are making measured ware, in which case the margin of contraction should be kept as low as possible. What is more important is that the over-grinding of flint produces dunting or shattering under the influence of a sharp knock even from a sorting tool. Years ago, if you will refer back to the Transactions, you will find that there were quite a number of experiments in the pottery classes which proves my point that too finely ground flint is dangerous from the point of view of dunting, as well as the contention that too coarsely ground flint promotes ready crazing. The experiments I refer to, which were made by Mr. Turner, went to show that flint up to a certain degree of fineness resisted crazing, and that over and beyond that point the body mixture commenced to peel, until, when the last stage of fineness was reached, the ware shattered and went to pieces. Over-ground flint, then, in an ordinary earthenware body appears to be very dangerous.

Mr. Turner :—It is correct that I made some trials on this subject years ago, since when Mr. Heath has amplified those experiments very considerably. I cannot just remember what the fineness of the flint really was, but there were seven or eight degrees of fineness, all of which were elutriated by the Schöne apparatus. The coarsest crazed very badly, whereas the finest peeled very badly. Between the two extremes there was an intermediate stage of comparative safety.

Mr. J. A. Calcott :—It may be remembered that I did some work for Dr. Mellor on crazing some years ago, and I found that if you had a glaze which fitted a normal body it would no doubt craze if the body were easy-fired, and it would also craze if the body were hard-fired. Unless you get a certain proportion of the alumina taken up by the silica through the action of the fluxes you are bound to get crazing ; if you have too much alumina present in the body, as you do in the case of easy-fired, you will get crazing ; if, on the other hand, you get too much silica taken up, as you do

in the case of over-firing, then there is not sufficient silica left in the body to prevent crazing.

Mr. A. HEATH :—When Mr. Leese and I found that our hard-fired ware crazed, we made up what looked like an impossible glaze, yet this gave perfect results on the hard-fired ware. I remember Mr. Moore criticising the chemical formula of the glaze, and suggesting that we must have made a mistake, but this theoretically impossible glaze certainly gave perfect results on the harder-fired pieces.

Mr. J. MEREDITH :—The experience of Messrs. Heath & Leese is interesting, but it would not account for a harder-fired biscuit frequently crazing less than easy-fired biscuit. I would like to ask for an expression of opinion as to what influences are at work when it is found that harder-fired biscuit crazes less than easy-fired biscuit.

Mr. RICHARDSON :—I think my previous explanation covers Mr. Meredith's question. The foundation of the whole business is the coefficient of expansion. It is perfectly reasonable that some hard-fired bodies with certain glazes will be perfect ; just as in the same way I suggest that possibly in the present case the glaze needs altering to make it suit the harder fired ware. It is utterly unreasonable to expect one glaze and body to fit perfectly both easy firing and hard-firing. It is not reasonable from a potter's point of view to expect that. Possibly the materials are not sufficiently flexible to play with. There is a certain latitude and no more. If you find you have an excellent result with hard-fired biscuit you must not expect that the glaze will suit easy-fired biscuit just as perfectly. Of course, easy and hard-firing are relative terms. What *we* speak of as easy-fired we should not care to take through a gauge for flat-ware. To my mind you cannot have a glaze which will cover the whole range of hard and easy-fired ware and do it satisfactorily. If you get really good results on the one side you must not expect equally good results on the other, that is to say if you get no crazing whatever with hard-fired biscuit, you will be extremely likely to get it with easy-fired biscuit. I have heard people say that they have a glaze that will accommodate itself to the one or the other, but I should want to see the pieces before I could feel sure that the claim was right.

Mr. W. LINDLEY:—I have come across the same phenomenon, but I have always attributed the result to coarse grinding. If the body is coarse ground, the harder-fired ware will stand much more chance of crazing than the easy-fired.

Mr. BISHOP :—I quite agree with that, but I can assure Mr. Lindley that in our case the trials have all been made on the same day from the same batch of clay, so that I do not think there

could possibly be much difference in the grinding.

Mr. LINDLEY :—The grinding might be different for all that. Was the material cylinder ground?

Mr. BISHOP :—No ; pan ground.

2—*Question*—Lead silicate frits often come from the kiln dark and discoloured. We have no difficulty with borax frits though the same equipment is used. How can this defect be remedied?

Mr. F. TURNER :—I have not seen a sample of this discoloured frit, but it is my opinion what is generally known as "smoked." You will all be familiar with the fact that for a lead frit an atmosphere should be maintained that is uniformly oxidizing. By a "smoked" frit I mean one that has been under the influence of a reducing atmosphere just previous to its being melted, and the colour is due to the inclusion of carbon in the frit or the reduction of lead compounds to metallic lead or possibly both. A lead frit is extremely susceptible to the influence of a reducing atmosphere at that particular time. I have seen lead frits before now come from the frit kiln with quite a lot of metallic lead. I would suggest that one way in which the trouble might be remedied would be to maintain a clear fire for a sufficiently long time previous to running off the frit. Quite how long I do not know, for the reason that I do not know how frequently the frit is run off, or how fusible the frit is. Assuming that the frit may be run off every two hours, then a clear fire should be maintained for at least an hour before running off, that is to say, approximately just after the frit has begun to melt. Even with an ordinary frit the same trouble from discoloration may be experienced, and to avoid this sometimes a very small proportion of nitre is introduced to act as an oxidizing agent. In that case, however, you have rather more margin. Usually the frit is not run off from the frit kiln oftener than once every 3 or 3½ hours, so that the fires have considerably more time in which to adjust themselves. In dealing with a lead frit, which comes off more frequently, great care should be paid to baiting. It is safer to bait immediately after charging. If that is not sufficient, a second baiting should be resorted to well before the time for running off. Personally, I think that if careful attention is paid to the baiting of the kiln, the trouble will be obviated without resorting to the use of nitre or anything else.

Mr. WM. CLEVERLEY :—Is it Mr. Turner's opinion that, once reduction has taken place, the maintenance of a clear fire will remove the ill effects, as I should think this very improbable?

Mr. F. TURNER :—No ; I cannot think that.

Mr. MEREDITH :—Would not carbon be more likely to be entangled in a frit during the early stages, seeing that at this time the frit is in a porous condition, and that the particles of carbon, once embodied in the frit, which would afterwards melt to a glassy surface, the entangled carbon would be very difficult to burn out?

Mr. HIND :—A lead glaze, put into a muffle kiln and reduced with ordinary coal gas, yields a brown discoloration, which is more or less uniform according to the degree of reduction which you allow. It seems to me that the two things are perfectly similar. By using a smoking flame you get entangled carbon particles in addition to the brown colour. There seems to me no reason to suppose that coal-gas, under these conditions would decompose so as to deposit carbon on the glaze.

Mr. B. J. MOORE: —The subject is obviously one which requires careful investigation and experiments. My own opinion is that the trouble is due to metallic lead. I have seen a frit totally discoloured and whole pockets of metallic lead being discharged from the kiln, but that would appear to be another problem. It is perfectly true that if you get a lot of smoke or gas emitted during the firing you may get carbon particles shut up in the frit which cannot burn away, with the result that discoloration ensues. That is a case where, in the early stages, a little nitre does help very much. I have made a considerable number of frits under all sorts of conditions, and I have always found that a little nitre counteracts that tendency in the early stages, for the oxygen given off helps to burn any particles of carbon. At a further stage of the firing, it is imperative to maintain a highly oxidizing atmosphere so as to obviate any danger of the lead in the frit reducing. By this means none of the lead is converted into metallic lead, such as serves to discolour the frit.

Mr. B. J. ALLEN :—I am inclined to think that the effect is entirely due to the reduction of lead in the frit, and that if you were to carry the effect a stage further you would encounter a blue discoloration, and even get, eventually, a slight lustre. If, after the blue colour is encountered, you resort to an oxidizing atmosphere, the blue will be destroyed, and the frit assume almost its original whiteness.

Mr. HIND :—When I spoke of lead I intended to convey the impression of the element, lead, chemically free. I think any chemist will admit that there is one stage between the ordinary lead salt and metallic lead. There is a sub-oxide. You may get another type of lead salt, just as you have at least two kinds of iron salts.

Mr. A. G. RICHARDSON :—I would like to support Mr. Turner's

remarks. I remember many years ago, when first we had to submit to special Government regulations in order to eliminate as far as possible any risks of lead poisoning, there was a tremendous amount of work done in regard to lead frits. At that time many manufacturers were engaged in making serious experiments and in discussing the matter with quite a number of their neighbours who were making lead frits. Most of us were suffering from metallic lead getting into the frit and also carbon discolouring the glazes. Quite a number of questions were brought up before the Ceramic Society at the time, and the remarks that the Chairman has made to-night seem to cover the bill entirely. When experiments were made upon that basis it was proved that the frits were cured by the avoidance of a smoking atmosphere at the critical moment before the fusion commenced. With regard to the suggestion made that it is rather dangerous to have smoke coming into the kiln when the charge is first put on, and that the accumulation of carbon in a porous material might be more dangerous, I myself do not think so, because afterwards, as the fire burns brighter an oxidizing atmosphere is obtained before fusion takes place, and the carbon is not shut in, for the porous mass enables the oxidizing atmosphere to oxidise any carbon that has been deposited and thus clear it away. I am certain that Mr. Turner's suggestion is a sound one, and that anyone having difficulties on account of enclosed carbon or reduction of lead can easily get rid of them by ensuring an oxidising instead of a reducing atmosphere.

Mr. B. J. Moore :—I am disposed to think that the fact that there is no difficulty with borax frits shows pretty conclusively that the fault is due to lead reduction.

Mr. F. Turner :—I did not suggest that the frit should be melted before steps were taken to ensure a clear fire. What I suggested was that the fire should be cleared before fusion takes place. Unfortunately, the frit-kiln fireman has got to bait *sometime*, and the best course undoubtedly seems to be when the kiln is charged. If the baitings are judged properly and the amount put on is estimated carefully, so that the fire has time to clear before the danger zone is reached, I feel sure the difficulty can be obviated. This, of course, can only be ascertained by experience and by a knowledge of the fusibility of the frit ; with a borax type of frit the period of the time will be considerably longer than in the case of a lead frit—in some cases, more than double.

Mr. A. Heath :—I think Mr. Turner's suggestion is perfectly correct, but it is my impression that the very haphazard method of mixing frits that is sometimes resorted to is likely to have a big bearing upon the question also. I have often noticed that where fritting has to be done during the night as well as the day, the day frits have invariably come out well, whereas those done during the

night have been much less satisfactory. I popped into one place last summer rather late at night after coming from the theatre, and I found the man shovelling the stuff straight into the hopper instead of passing it into the mixing trough first, as he would have done during the day when usually there is supervision. In a case like that you may expect to experience reduction rather badly.

Mr. W. Emery :—I would like to ask whether any of the speakers who have had trouble from discoloured frits due to imprisoned carbon have noticed any difference in the viscosity of the frit as it comes from the frit-kiln?

Mr. J. S. Hutcheson :—I have had no experience at all of making frits, but before I came into the ceramic industry, I did many thousands of fusions of gold ores, in which connection I used a flux which was comparable with the chemicals that are used in the making of pottery glaze frits. It was very noticeable that if you are fusing a pyritic ore, the glaze after fritting is solidified as an extremely black opaque mass, whereas, when a non-pyritic ore is fused, the resulting glaze is clear, but tinted slightly blue. I would suggest that a sulphurous coal might at times exert equally as detrimental an effect as the influx of smoke. In my opinion you are likely to run more danger from the sulphides of iron than from the carbon as an agent making for the reduction of lead.

3—*Question*—Why does a cast pot show a tendency to crack whilst in the clay state at the seams where joints in the mould occur?

Mr. A. Leese :—I am not pretending to answer this question as it stands, but I will suggest a few things which may lead to cracking at the seams.

Shapes. The question makes no mention of zig-zag or irregular seams. These shapes would have a suspending effect as soon as contraction commences, thereby opening or cutting the surface.

Condition of Moulds. When made from cases, moulds are liable to have a thicker film of size at the seams. This would retard suction, leaving the body soft and moist, which would be likely to tear when contraction commences. After some wear, the joints of the moulds become rounded off, giving two drying surfaces opposite each other, which quickly absorb moisture, thus reducing the plasticity and tensile strength at this point, so that the seam tends to give way under the strain of contraction of the whole body. In old moulds, this defect is more pronounced, the rounded joints having a tendency to hold the piece until the seam breaks away, leaving a fractured surface. With new moulds on the other hand, sharp, keen edges at the joints lead to a "cutting" at the seams. Rough handling

of moulds after casting will cause a movement at the seams which very often develop cracks, especially if the natches are worn.

4—*Question*—What is the effect of fine ground or overground flint on a (*a*) Vitreous earthenware body;
(*b*) Semi-porcelain body;
(*c*) Earthenware ivory body?

Mr. J. A. Calcott :—I have been asked by Dr. Mellor, at rather short notice, to reply to the three points embodied in this question. (*a*) In the first place I think you have to assume that the vitreous body consists of high stone, medium ball and china clay and low flint. In that case over-ground flint will give a tendency towards slightly increased plasticity in the vitreous body, together with slightly increased contraction, and probably you will get a little blistering through vitrification taking place too rapidly during the firing. I do not think you will get crazing, for the simple reason that you will make a glaze to suit the vitreous body.

(*b*) As regards the semi-porcelain, one has to assume that the flint is high, and stone high and the ball and china clay medium. The contraction and plasticity will be in proportion to the amount of finely ground flint which you admit. In a semi-porcelain body the plasticity would be greater because the flint is in greater quantity; so also the contraction would be greater. I have found that in a semi-porcelain body, when finely ground flint is employed, you are liable to dunting, especially in the case of the larger pieces, both in the biscuit oven and in the enamel kiln.

(*c*) In the case of the ivory earthenware body, the ball clay will be high, the flint and china clay medium, and the stone low. The plasticity will be slightly increased because the flint is only present in medium quantity. The contraction also will be slight. You will be liable to cracking in the clay, owing to the increased density of the body, which means that the clay is not so ready to give off its water. You will also be liable to warping in the oven, and probably crazing in the case of hard-fired biscuit. I think that question has been fairly well discussed to-night. I have found that with the hard-fired ware there is too much flint taken up through the action of the fluxes with the silica, which does not leave sufficient flint in the body. I have regarded crazing as being due to the fact that in the case of an easy-fired body the glaze is too small and in the case of hard-fired ware too large.

Mr. B. J. Moore :—We have a non-dunting body in which we specially included under-ground flint in order to minimise dunting. The body contains the same amount of flint as any of the other bodies, but it is not so finely ground. We use it for very delicate biscuit ware. The liability to dunting is much less in the case of

that body, but the risks of crazing are appalling. We have now decided to run the risk of dunting rather than the greater risk of crazing. At one time we used to get whole batches of crazed ware, which we attributed at first to easy firing, but we afterwards discovered that it was not the fault of the fireman, but due to the condition of the flint.

Mr. W. LINDLEY:—I heard a somewhat peculiar view expressed last month. A pottery expert was telling me that he was experiencing a good deal of breakage in the greenhouse, which he attributed to the fine grinding of the flint, and the reduction of its adhesive power. I simply mention this view for what it is worth.

5—*Question*—Is it advisable to use the same mixtures for china and earthenware saggars?

Mr. B. J. MOORE:—I presume that this question really has reference to china or earthenware biscuit saggars; if so, I would say that in my opinion it is inadvisable to use the same mixtures if the green saggars are fired in their own respective ovens, that is to say, the earthenware biscuit saggars in the earthenware biscuit oven and the china biscuit saggars in the china biscuit oven. The essentials of a good saggar, assuming that the materials used are free from any undue proportion of impurities such as iron pyrites, seem to be long life and the ability to keep straight under fire. A saggar having these properties at the earthenware biscuit heat would be too vitreous for china and would be liable to bend. A satisfactory saggar for china biscuit, on the contrary, does not vitrify sufficiently at earthenware biscuit heat to withstand normal handling by the placer. Mixtures I have successfully used are as follows:—

Earthenware biscuit:	25 ball,	25 china,	50 grog.
China ,,	12 ,,	36 ,,	50 ,,

I do not want to suggest these are standard mixtures; I merely give them in order to illustrate the difference between the amount of comparatively fusible clay introduced into an earthenware saggar as compared with the amount of less fusible clay introduced into a china biscuit saggar which has to withstand a high temperature up to say cone 10. The best mixtures will vary somewhat with different conditions of firing—and, in my opinion, can only be determined in practice.

6—*Question*—Why does a glaze containing tin oxide produce a ruckled or pimpled surface when a slow-dragging fire is used in the final stage of firing?

Mr. MEREDITH :—The defects which are usually associated with glazes containing appreciable amounts of tin oxide, and which form the basis of this question, appear to be due chiefly to two main causes. 1. Its extreme fineness and 2, its very refractory character. To deal with its fineness first. A good sample of tin oxide, and one which will give a high degree of opacity, will pssa through a 200's lawn and leave a negligable residue. Opaque glazes containing 12½% of tin oxide are not uncommon, and if this amount of a very finely divided material is added to a glaze which is already well ground a decided tendency to "ruckling" will be experienced. The glaze cracks on drying and in the early stages of the firing, and probably never becomes sufficiently fluid to flow evenly over the ware and obliterate these cracks, and the "ruckled" surface is the result. In producing this effect, the same forces are at work as when one sees a globule of water roll about a dusty surface without spreading and soaking into the surface. The affinity of the minute particles for each other is greater than that of the covering layer for the underlying surface. The glaze is subject to two attractions. 1—that of the particles for each other (and this will be the greater the finer the particles are), and 2—the attraction of the pottery for the glaze which covers it. Ruckling will be decided by the balance between these two factors. This also explains why—other things being equal—thickly dipped glazes always rucks worse than thinly dipped glaze. The remedy is obvious. 2. The refractory nature of tin oxide. It is a common practice on factories to make an opaque glaze by adding tin oxide to a glaze already in use. This addition has the effect of reducing the fluidity of the glaze, and of making it more refractory and necessitates a considerably higher maturing temperature to bring out a glossy surface. If this higher maturing temp. is not reached the glaze comes from the kiln showing a pimpled surface, which may be remedied either by increasing the fusibility and fluidity of the glaze, or by increasing the temperature at which it is fired. Fritting the tin oxide with the glaze would also tend to reduce both defects, since its influence would be in the same direction as the suggested alterations.

Mr. A. HEATH :—Do I understand Mr. Meredith to say the tin is mixed with the glaze? In my opinion it ought to be ground along with it to get over the difficulty.

Mr. MEREDITH :—Tin oxide is supplied commercially in a very fine condition. By merely mixing it up with water, making it into a slip, and passing through a stain lawn, it can be mixed with the glaze reasonably satisfactorily, and an opaque glaze is obtained in that way, but it usually has this pimpled surface. I take it that the glaze does not sufficiently mature to assume a good glossy surface.

Mr. HEATH :—My contention is that grinding with the glaze

instead of merely mixing with it would give a better result.

Mr. HEATH :—The only experience I have had is with iron enamels. These have a very quick fire. About three minutes does it. We found that we got very different results, however, by grinding the tin along with the enamel than we got with merely mixing the tin along with it. The difference was very marked.

Mr. MEREDITH :—There are two points which have been raised in the discussion to which a reply seems necessary. In the first place, when temperature is measured by cones it is scarcely as accurate as when measured in degrees centigrade by pyrometer, and a "slow, dragging fire"—to use the words contained in the question—which reaches a certain cone, would not necessarily be the same degree of temperature as when the same cone was bent with a much quicker fire. With a slow dragging temperature you are dependent upon the assistance of time ; you are not reaching the same degree of temperature as when the cone is brought down with a quicker fire. The second point is that it is a common experience that quickly fired glazes are glossier than when the same glazes are given a longer fire. The point that comes in there, seems to be surface tension. The surface tension is greater with a quickly fired glaze, and the glaze is glossier than it would be with a slow dragging fire.

Mr. B. J. MOORE :—I have seen a good deal of this fault. The glaze sometimes comes out perfect, looking quite like a bright lead glaze ; at other times it is quite egg-shelly.

Mr. BISHOP :—You sometimes have the same result with a glost oven that is sharp finished. Is it not possible that the cause is the same?

Mr. MOORE :—Tin glazes are particularly liable to pin-hole. I do not know why.

Mr. B. J. ALLEN :—The point is, why does a slow, dragging fire give a pimpled surface to the glaze, when a quick finish to the same temperature, as indicated by cones, Bullers' rings or pyrometer, gives another result? It invariably happens that a slow, dragging fire gives a pimpled result, whereas a rapid fire towards the finish yields a brilliant glaze. It is not the experience of this country alone. Years ago the Americans, when they were using tin enamels, suffered very badly from this fault ; it was so bad, in fact, that they could not remedy it by re-firing, and sand-blasting was resorted to in order to break up the bubbles or blisters, and even then satisfactory results were not obtained.

Mr. HEATH :—Is the long, dragging fire at all necessary? If a quick fire will bring the glaze out properly why not have a quick fire?

Mr. ALLEN :—You do not usually find out until your oven is finishing that the temperature is not rising rapidly enough. It is not until some hours afterwards that you find out that the oven has been dragging sufficiently long to effect the glaze.

Mr. W. LINDLEY:—Would an extra addition of lead help the oxide of tin at all—that is to say, would it tend to bring the glaze to a shiny condition any sooner?

Mr. MEREDITH :—Anything which increases the fluidity and fusibility of the glaze should help to cure the fault. Increased fusibility should help to counteract the refractory nature of the tin oxide.

VI.—A Recent Visit to some Spanish and Portuguese Potteries.

LECTURE BY W. LINDLEY.

(REPORTED BY H. TOWNSEND.)

MR. W. Lindley delivered a very interesting lantern lecture dealing with a recent visit to some Spanish and Portuguese factories. More than ordinary interest attached to this lecture by reason of the fact that for many years Mr. Lindley actually worked as a pottery manager in this part of Europe, and is, consequently, specially qualified to speak of Southern European pottery development.

Beginning with Lisbon, where a month's tour of Spain and Portugal was commenced, the lecturer spoke of the changes which have occurred in the Portuguese capital since he was there twenty years ago. He remarked on the fact that Portugal seemed to have suffered from the recent European war more than any other of the Allies, because of the fact that she possessed fewer natural resources. Industrial unrest was most marked, and strikes were the order of the day. The rate of exchange was very unfavourable to Portugal, as was evidenced by the fact that twenty-one dollars were received for the English pound Treasury note, equal to nearly £4 10s.

Presenting themselves in Lisbon at the depôt of one of the largest works—that of Gilman, Ltd.—the gentleman there in charge conducted them to the headquarters of the pottery at Sacavem, situated about seven miles up the River Tagus. This pottery, from a manufacturing point of view, was splendidly located. The Tagus ran along the one side of it, and the main railway line connecting the Portuguese and Spanish capitals along the other side, providing all the requisite sidings for dealing with the receipt of raw materials and the despatch of the finished goods. It was distinctly novel to see huge bunches of grapes hanging from the vines around the factory, and oranges and other luscious fruits from the trees. One could not help contrasting the difference in this respect between a Portuguese pottery and an ordinary Staffordshire manufactory.

Beginning with the sliphouse—always the best point at which to commence to tour a factory—it was observed that this was a commodious building, well designed for its purpose. A most striking feature was the "body," which did not contain the least particle of flint or stone, but simply silica sand, felspar, and a very slight admixture of china clay and ball clay. The filter presses in

use were of the large iron type, made and patented by a well-known firm of engineers in Hanley. These presses were used for the dinner, toilet, and teaware, although it was noticed that an old Furnival thirty-chamber wooden press was still used for the sanitary ware and the tiles. The firm generated its own electricity, and used electro-magnets for the clay. The sliphouse also contained some jumbo 7-ft. cylinders, of which a number were seen to be grinding the sand and the felspar, and appeared to be giving very satisfactory results.

In the potters' shops there was not much that was new to be seen. Possibly this was due to the fact that the firm always employed Staffordshire mould makers and modellers, who took the Staffordshire customs with them. Extensive use was made of casting. The firm was evidently delighted with its first attempts at casting, and started to develop the process extensively, extending it even to the making of chambers. They discovered, however, in the course of time, that casting was not always a successful rival of the jolley, especially the round jolly, and they consequently reverted in due time from casting to jolleying for certain lines which could be produced more satisfactorily by that method.

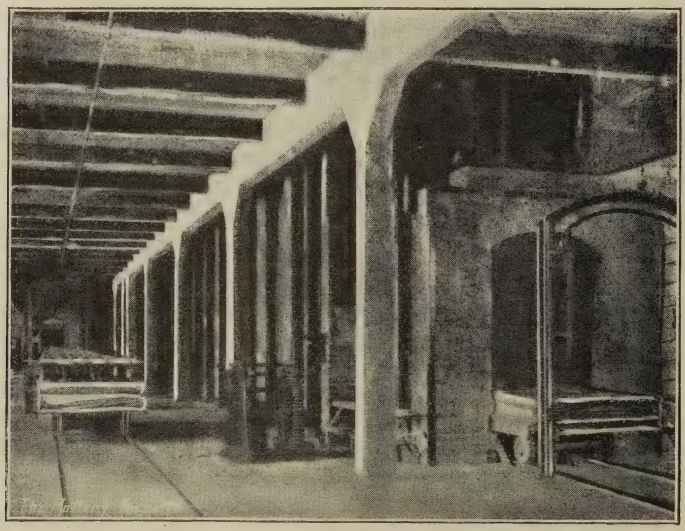
It was mentioned by the lecturer that the Sacavem pottery possesses its own ball clay mine, situated amongst the pines in the neighbourhood of the factory. The clay was cut by the clay-getters into square blocks of just about the same size as they would come from an ordinary pug. Without the slightest treatment, this particular clay was used in the manufacture of stilts, which were made by the firm themselves at the pottery.

The factory possessed in all twenty "Beehive" ovens, but many of these had passed out of commission since the installation of a large tunnel oven. What "Beehives" were still used were simply utilised for the biscuiting of tiles and bricks. The dinner-ware, general earthenware, and glost tiles nowadays all passed through the tunnel oven. The lecturer said that for the past ten years or more he had kept in close touch with the development of this particular oven; the owners had been in constant correspondence with him regarding it, and they had always expressed the highest opinion of its capabilities and advantages. It was an oven of the Faugeron type, very much like the Dressler or the Marlow oven in its general appearance, but open-fired. The fuel was not converted into gas, either wholly or partially. The inner chamber of the oven, being unmuffled, did not readily get out of order, and firing could proceed continuously for a period of two or three years without any stoppage for repairs. The oven was 85 metres long—equal to about 275 ft. The saggars were fired naked, and were placed five high, four deep, and three wide—*i.e.*, sixty saggars on each truck.

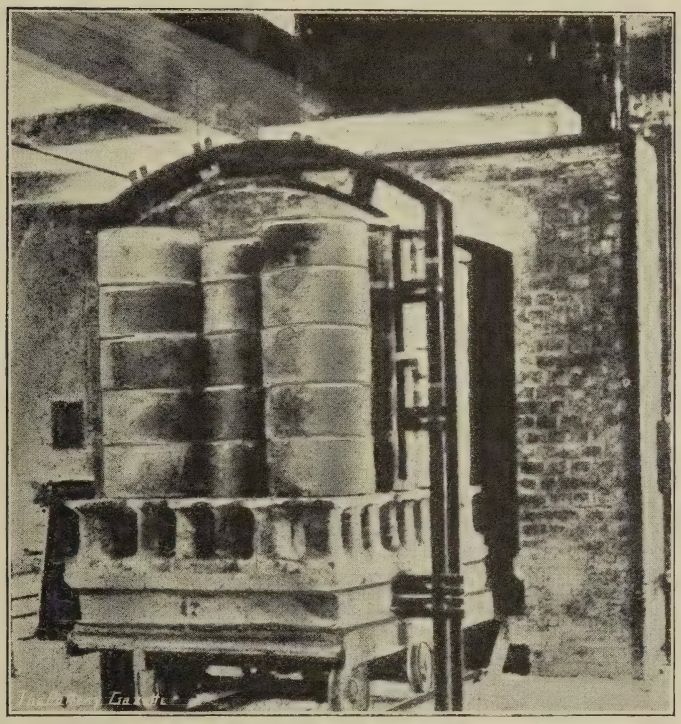
The tunnel oven in question was primarily constructed for the consumption of coal, but slight alterations had recently had to be made to render possible the burning of wood. Necessity was the

mother of invention, and when, during the war, the exportation of Scotch coal was entirely prohibited, the firm had to devise some means of utilising the native resources of their country, otherwise the factory would have been compelled to close down. The results of the firm's experiments with wood fuel had convinced them that wood was much more satisfactory for this particular type of oven than coal, seeing that the former did not so quickly choke the flues, and did not eat away the firebricks to anything like the same extent. When the oven had been stopped from time to time for a clean-up they had been pleasantly surprised with the general good state of the fire zone. The best class of wood fuel was considered to be eucalyptus; next in value came corkwood and oak. Pinewood alone was not considered to give satisfactory results, although it was thought that if the oven had been specially constructed originally for the burning of wood, no difficulty would have been experienced even in the burning of pinewood.

In outlining the advantages which had been derived from this tunnel oven, the proprietors of the Sacavem pottery laid great stress upon the facility with which the trucks could be loaded. They considered that the filling of the Staffordshire bottle-shaped oven was the work of an acrobat. To climb up a ladder with a large and well-filled saggar of ware, balancing it the whole time, and place it squarely and securely at the top of a high bung, they regarded as something in the nature of a feat. In the case of the tunnel oven, the trucks were quite low, and from a very small



The Runway of the Faugeron Tunnel Oven.



Entrance to the Faugeron Tunnel Oven.

platform the placer could command the whole surface, placing the whole of his saggars without any great exertion. Similarly, the unloading of the saggars could be performed with every facility. There was also the advantage of being able to deal smartly with "rush" orders, whereas, in the ordinary ovens, there was always the unavoidable delay of having to place the entire oven—firing, cooling, and drawing. The tunnel oven at Sacavem was, however, considered to be much more exacting in regard to the saggars, which, it was alleged, did not last so long as when used in the ordinary intermittent ovens. There was a distinct advantage with the tunnel oven in respect to the facility with which the waste heat could be harnessed, and at Sacavem the tunnel oven was now being built over, so as to enable the waste heat to be utilised for the drying of saggars, firebricks, and tile dust. Above this drying room additional potters' shops were being constructed, which would also be heated from the same source.

The Sacavem tunnel-oven was certainly giving very good results if statistics in regard to percentage losses could be taken as a criterion.

There was said to be absolutely no crazing, and little or no loss from crooked ware, either in bisque or glost. The percentage loss with hollow-ware was put down at $1\frac{1}{2}$ per cent.; in flat-ware the loss was said to be somewhat higher, but no exact figure was mentioned. With eight tons of wood it was said to be possible to fire a volume of ware equal to the contents of an ordinary "Beehive" oven. A truck of bisque ware was fired every hour, and a truck of glost ware every half-hour, the labour entailed being only half that required for an ordinary round oven. With tiles the oven was said to give results even more remarkable; 120,000 tiles were said to have been produced recently with only 0·5 per cent. of seconds.

It was particularly interesting to notice how the tunnel oven had safeguarded the Sacavem pottery during the war. When coal got into the region of £40 per ton, several competitive houses, not provided with tunnel ovens, had to close down, whereas Sacavem was able to carry on, at first with half wood and half coal, but eventually with wood alone. The proprietors now declared that, even though the price of coal might, in course of time, go back to normal, they would still prefer to fire with wood, which is freer from sulphurous fumes, and does not give clinker troubles. The main disadvantage of wood as a pottery fuel was, of course, its bulkiness. In the Staffordshire potteries there would hardly be a single firm who could handle it, even though they could obtain it. About $2\frac{1}{2}$ tons of wood were required to perform the work achieved by a ton of coal, and its bulk was five or six times that of coal. At Sacavem an organised mule team was to be seen running up and down the factory distributing the wood to the various points at which it was required. The distribution of the wood was certainly a big business.

It was obvious to anyone connected with the pottery trade that the saggars produced at Sacavem did not last long. Fully half of those that were seen being drawn from the ovens were in two parts, and they were of a peculiar hue. In order to make the broken saggars serve another "trip" through the oven, they were bound round by girls with flexible wire. The saggars were made by hydraulic power, on very much the same lines as the local patent hydraulic saggar with which the Staffordshire potters were all familiar.

The underglaze printed patterns at the Portuguese factory were not hardened on, but the printers' oil was neutralised by the use of a weak solution of sulphuric acid—a solution not sufficiently strong to injure the hands of the workpeople coming into contact with it. The solutioning of the printed ware was entrusted to a boy, who placed the solutioned ware in bungs in a position convenient to the hands of the dipper. A leadless glaze was used, and the results obtained with it were said to be very good.

In the tile department a very interesting tile brushing and dipping machine was encountered. The tiles to be dealt with

were placed upon a travelling belt, which ran fairly quickly, and conveyed the tiles towards a coating roller, which imparted just the requisite amount of glaze to the surface of the tile, without any smearing of the sides, and, consequently, obviating any cleaning off. At the other end of the belt, girls were waiting to receive the glazed tiles, and within a few seconds of the time that the tiles were placed upon the belt they were brushed, dipped, and placed in the saggars.

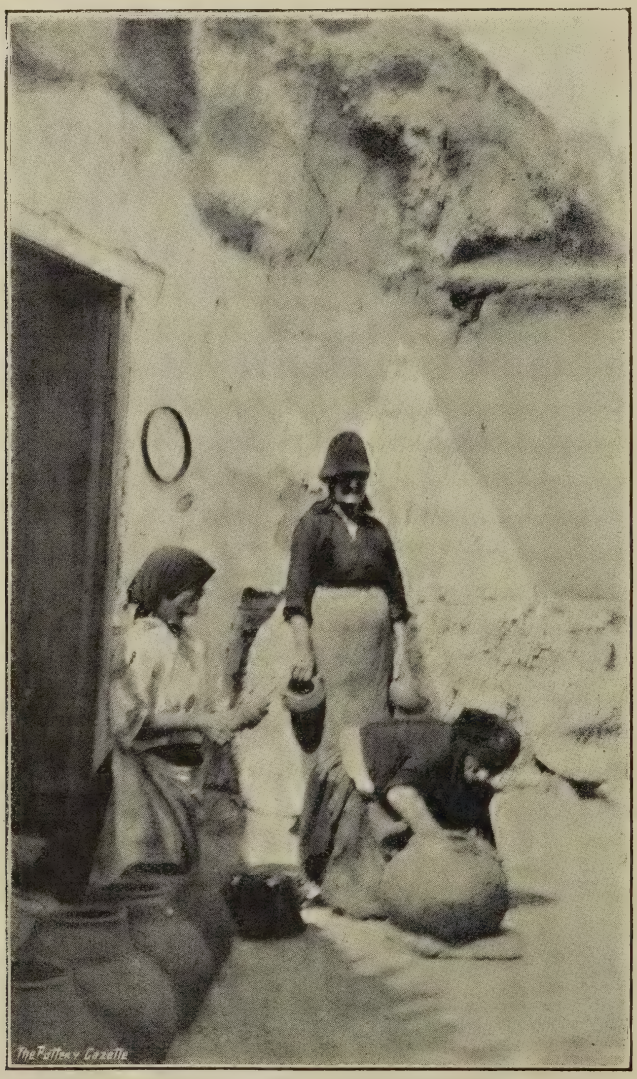
In the printing house Hassall's roller printing machines were seen to be chiefly in use. It was true that a few hand-printing machines were employed, but these were merely used for the printing of the smaller orders. It was observed that several extremely old patterns were still in strong demand, some of them, such as the "Willow" pattern, having been produced by the factory for fully half a century. The firm printed their own stationery and produced all their own ceramic lithographs. The decorations were on much the same style as the English patterns, but the medium employed for transferring the patterns was gelatine, which was kept warm amd brushed on to the transfer. Of the two methods the lecturer said he preferred the English one, which, he thought, was easier on the whole.

The "Climax" kiln was seen to be in use at Sacavem, and apparently it lasted quite a long time before having to shut down for repairs. He was given to understand that one of these particular kilns had operated for as long a period as fifteen months without having to stop for attention. Soon after this type of automatic kiln had been installed, the firm discovered that, unfortunately, there was some possibility of the night man falling asleep, which had a very detrimental effect, not only upon the ware, but upon the kiln. A remedy was found, however. Small timing pieces were placed in each cage. At five o'clock in the evening, when the manager left the factory, a particular timing piece was put in, and this piece was seen drawn at a specified time the next morning. Since the adoption of this method the "Climax" kiln had given exceptionally good results.

In the packing house it was observed that the receptacles employed were usually wooden boxes about thirty inches square. The reason for this was that, at the majority of the intermediate railway stations between Lisbon and Madrid, haulage facilities were not provided, and the packages had to be of a suitable size for a man to handle.

A number of samples of the productions of the Sacavem pottery were displayed by the lecturer, who emphasised the fact that the factory is chiefly engaged nowadays in the manufacture of ivory ware. During the war it was impossible to get supplies of cobalt, as the Portuguese Government vetoed its use. Since the war the ruling price of cobalt had been prohibitive, and so the firm had decided to do without it, and to make ivory ware in preference to white.

In the concluding stages of his lecture Mr. Lindley briefly outlined a visit to some of the sources of rude and primitive Portuguese pottery which were later visited by him in the neighbourhood of Madeira. A very interesting day was spent amongst the cave-



Cave Potters at Work.

dwellers in the Grand Canaries. Here the womenfolk were the potters, and at Atalya, near Santa Cruz, some beautifully potted rough wares were made without any sort of manufacturing appliances. Not even was the primitive potter's wheel employed. The piece of clay was simply put upon the ground, opened out, taken from or added to, and in quite a dexterous way worked up by hand. It was astonishing to see what large vases could be made by these native workers, without recourse to any form of whirler. One of these women, who was engaged in making large milk coolers, about eighteen or nineteen inches across by about four or five inches deep, was questioned as to her earnings. She replied that she could earn about 1s. 8d. a day, and make about a dozen daily. From that he came to the conclusion that it would hardly be worth while sending out to the Canary Islands anything in the nature of expensive pottery plant, which could never be expected to produce a vessel of that size and character any cheaper. Some very interesting slides of the cave potters at work were shown by the lecturer, one of which will be found reproduced below.

It was explained that the water coolers shown in the illustration are an essential article in all hot climates. They are only half-baked in an old-fashioned type of bread oven, fired with sticks. When the sticks are burned away, the ware is fired. The clay, being of a rough and open character, does not readily disintegrate, and the porosity of the fired piece imparts to the cooler a peculiar capacity for keeping its contents cool, even on the hottest day. The wares made by these cave-dwellers are sold by the local hawkers, who toboggan with panniers of ware down the mountain side, and sell a goodly portion of their merchandise alongside the ships moored in the harbour. Their wares stood out in striking contrast to the highly commercial productions of the Sacavem pottery, but the conditions under which the wares were produced were extremely interesting to anyone who might be concerned with the production of pottery of whatever class.

A tour such as that which was described by Mr. Lindley in his lecture is certainly both interesting and educative, and his account of it, illustrated by numerous photographs and lantern slides, was much appreciated, and provided a diversion from the somewhat dull and highly technical subjects which are more often brought before the Society for consideration.

DISCUSSION.

Mr. F. S. Worthington:—Can Mr. Lindley explain how it is that the Sacavem pottery use the iron filter presses for their table and toilet ware, whereas, for such large pieces as sanitary ware, they use the wooden presses?

Mr. Lindley:—This is simply because they cannot get sufficient clay from the iron presses. They have the wooden presses

by them, and utilise them in that way. At present, sanitary ware is made by the firm in lesser bulk than either dinner or toilet ware. They are hoping, later on, to get iron presses for the sanitary ware also.

Mr. F. S. WORTHINGTON:—What I am trying to get clear in my mind is whether the use of the iron presses for the dinner and toilet ware and the wooden presses for the sanitary ware is determined by the condition of the clay as it comes from the presses.

Mr. LINDLEY:—Oh, no. There is no such suggestion.

Mr. CUTHBERT BAILEY:—Can Mr. Lindley give us any information as to the approximate cost of the wood delivered at the factory? Can he also state how long the Faugeron oven has been in operation, and whether the owners are troubled at all with the cooling of the ware—that is to say, are the trucks found to be reasonably cool when they reach the exit point?

Mr. LINDLEY:—The cost of the wood delivered at the factory was, at the beginning of the war about two-thirds the price of coal. Now I think it comes to something like 15/- per ton. In answer to Mr. Bailey's second question, the ware was not very cool when it came from the mouth of the tunnel. I laid hold of some of it, and I remember dropping it pretty quickly. It is some 10 years since the Faugeron oven was first put in. At first, as I have explained, it ran entirely on coal, and for a time it gave some trouble, but the firm has persevered with it, until they have now arrived at results with which they are apparently delighted.

Mr. CUTHBERT BAILEY:—Has it been found necessary to make any serious structural repairs?

Mr. LINDLEY:—Practically none. The oven seems to last for years without working out. The general structure is not punished any more than is the crown of one of our ordinary beehives. Personally I cannot conceive of its being thrown out of action for ten years yet.

Mr. ASHLEY MYOTT:—Have they the same carriages running through now as at first?

Mr. LINDLEY:—Yes. The seal protects the ironwork very much.

Mr. BAILEY:—What is the seal?

Mr. LINDLEY:—Sand.

Mr. D. F. W. BISHOP:—At what particular temperature do they fire this tunnel oven? And is any difference noticeable in the plasticity of the body as compared with the ordinary Staffordshire body?

Mr. LINDLEY:—The temperature of the oven is about 1050 deg. C. for the glost, and 1150 deg. C. for the biscuit. It is found to be a fairly simple matter to move from biscuit to glost within an hour. All that this entails is the heaping on of more wood. The temperature is soon increased from glost to biscuit heat. Answering Mr. Bishop's second question : the clay is not quite so plastic as our ordinary clay in the Potteries. At first it gave some little trouble, particularly in the pugging, but fewer knives were put into the pug, and better results experienced afterwards. The clay is found to be much better for working if it is allowed to stand for a week before it is used.

Mr. CUTHBERT BAILEY:—Can Mr. Lindley tell us the length of the firing zone of the tunnel ?

Mr. LINDLEY:—I am sorry, but I did not ascertain that. It seemed to me to be rather long. The kiln itself is long, as you will have gathered. I will ascertain the length of the firing zone and report this later.

Mr. D. SINGH:—Are ordinary firegrates used for the wood, or producers ?

Mr. LINDLEY:—The wood is direct-fired. The grates are just like the ordinary oven mouth, but a little larger.

Mr. F. R. WOOLDRIDGE:—What is the distance from the oven mouth to the exit of the chimney ?

Mr. LINDLEY:—I am afraid I cannot tell you that. The chimney seemed to me to be a considerable distance away. It is fairly direct and straight. There is never any blockage.

Mr. F. R. WOOLDRIDGE:—Is it possible to give us any information as to the height of the chimney ; and does it work with a damper or a baffler ?

Mr. LINDLEY:—That I could not say. The chimney seemed to be of a good height—not quite so high as the Shaw chimney, possibly about 20 feet lower.

Mr. ASHLEY MYOTT:—At what rate do the trucks travel through the tunnel ?

Mr. LINDLEY:—A glost truck is drawn every half hour and a biscuit every hour.

Mr. ASHLEY MYOTT:—And how many trucks are there in the tunnel ?

Mr. LINDLEY:—I think about 30, which is equal to 30 hours for a biscuit to pass through from one end to the other.

Mr. CUTHBERT BAILEY:—Is there any variation encountered in the temperature of the top and bottom of the trucks ?

Mr. LINDLEY:—No, not much. I examined the ware carefully and could not trace anything which indicated under-firing or over-firing ?

Mr. ASHLEY MYOTT:—I understand this is the same type of kiln that has been worked very successfully for many years at the works of Boch Frères, La Louvière, as well as for the manufacture of German china at Altwasser.

Mr. LINDLEY:—Yes.

Mr. S. R. HIND:—Can Mr. Lindley give us any information as to the chemical or scientific reasons why the Sacavem pottery uses sulphuric acid in the process of hardening on ?

Mr. LINDLEY:—I am afraid I must leave that to the chemists of our Society. Sulphuric acid was used in this district also at one time, but to-day most of us manage without hardening on. The sulphuric acid seems somehow to kill the oil for the time being. I believe Grindley & Co. used it for many years. I regret I am not in a position to say just how the sulphuric acid works, but it has been found to be useful.

Mr. C. D. GRIMWADE:—Does the firm experience any difficulty in changing over from biscuit to glost ? In other words, do they get any over-fired glost ware or under-fired biscuit in changing over from the half-hour firing to the hour firing ?

Mr. LINDLEY:—No. What they do is to pass the first biscuit truck into the firing zone and leave it there for half an hour longer.

Mr. BAILEY:—Would they not send through first a truck of green saggars ?

Mr. LINDLEY:—No. I don't think so. They are too badly in need all the time of actual ware.

Mr. ASHLEY MYOTT:—Possibly they can get over the difficulty by firing a truck of holloware in the interim ?

Mr. LINDLEY:—They might, of course. But they do not fire quite so hard on the average as is the general practice in the Staffordshire Potteries.

VII.—On the Porosity, Strength and Absorbing Power of certain Calcium Sulphate Cements.

By Alice B. Taylor and Edith Irvine, B.Sc.

During the course of experiments on the slip casting of clays under pressure, (1), the authors found that further knowledge of the porosity and hardness of plaster of Paris would be advantageous to their work. Moulds were needed which would stand a pressure of 5 to 20 lbs. per sq. inch, which would not deteriorate rapidly and which would remain of sufficient porosity for suction purposes. While the usual methods of reinforcement were fairly satisfactory, it was felt that a plaster could probably be prepared which would be sufficiently resistant without reinforcement.

The setting process of plaster of Paris has been studied by a large number of investigators. Dr. Desch, at the close of his paper on the "Setting of Plaster" (2)—practically a summary of work done in this direction—has given a list of references which includes the work of Rohland, Marignac, Van't Hoff, le Chatelier, &c. Other investigators are Glasenapp (3) Keane (4) Bakker (5), Williams (6), Haddon (7), Ostwald & Wolski (8). The amount of information on the subject is therefore considerable. The main cause of setting, as pointed out by le Chatelier and by Marignac, is that the hemihydrate, $2CaSO_4.H_2O$, which constitutes the bulk of ordinary plaster, is much more soluble at room temperature than the dihydrate, $CaSO_4.2H_2O$, and that the latter precipitates readily from a highly super-saturated solution. Although this is established, there seems to be a difference of opinion as to the exact nature of the process. This difference is marked in the discussion on the use of certain salts as accelerators or retarders of setting. Rohland states that in general those substances which increase the solubility of the hemihydrate should allow of a more rapid crystallisation on the part of gypsum and should therefore be accelerators, while C. S. Haddon (7) finds in practice that the sulphates are all accelerators, though in general they decrease the solubility of the hemihydrate. Ammonium acetate he found to act in the opposite direction, increasing the solubility yet being a fairly efficient retarder.

It seems probable that, although the solubility relations of the various hydrates of $CaSO_4$ seem very simple at first sight, the processes involved are decidedly complex, The deposition of the

dihydrate, depending initially on the solubility of the hemihydrate, is naturally modified by its ability to form saturated solutions in the presence of various reagents. Le Chatelier and Salvétat (9) recognise an α and a β variety of the hemihydrate of different solubilities besides two forms of the anhydrous salt and also an α and a β dihydrate of different crystalline structure, one passing into the other during the setting process.

Much work on the action of catalysts on the setting of plaster of Paris has been done by B. R. Bakker (5). His method was to take a definite quantity of plaster of Paris and mix it with a definite quantity of water containing a small amount (1-10%) of the salt in solution. He then took a time-temperature curve of the reaction; the time taken to reach the maximum temperature he called the "time of hydration" of the mixture. He then plotted these time values against the concentrations of the added salt, and so obtained a curve for each catalyst showing at what strength maximum acceleration or retardation of the process of setting was achieved. Of the salts that he tried, the accelerators were in the majority, *e.g.*, potassium sulphate, chloride, nitrate, alum, &c. Some few acted both ways, retarding if dilute and accelerating if added in more concentrated solution, *e.g.*, sodium carbonate. He found borax to be the most efficient retarder, a 1% solution increasing the time occupied by the heat evolution from 18 minutes to one hour.

According to C. S. Haddon and G. A. Williams (6), other retarders are lime, gum tragacanth, dextrin, sodium bicarbonate, and ammonium acetate.

The recent work of W. Ostwald and P. Wolski (8) upon dilute plaster mixtures (3-5%), includes a study of the effect of the addition of various reagents, potassium chloride, acetic acid, ammonium chloride, gelatine and alcohol, upon the viscosity of the system. These authors measured the flow of different plaster suspensions at definite time intervals after the original mixing. The time-viscosity curves so obtained are of the same general ~—shape as the time-temperature curves of Bakker, although the latter used mixtures which were fifty times as concentrated.

Realising that research had been in the main confined to the study of the setting process of plasters and that very little was known as to the actual strength, porosity and absorbing power of prepared plasters, the authors set out to measure these properties. They also made use of the retarding effect of borax to produce mixtures containing a higher percentage of plaster than can be prepared with water alone.

The first series of experiments was made to test the effect of the amount of water used in gauging the plaster on the porosity, crushing strength, and Brinell hardness. Throughout the work the plaster used was the "Fine White Cafferata Plaster" supplied by the Cafferata Company, Newark-on-Trent. Analysis of the plaster gave the following results :—

Moisture (loss at 105°C)	3·59
Combined water	5·34
Silica	0·14
Ferric Oxide and Alumina	traces
Sulphuric Anhydride	52·69
Lime	37·94
Magnesia	trace
	99·70

Briquettes were made of plaster thoroughly mixed with water.

The following proportions by weight of plaster to one part by weight of water were used :—0·6, 0·8, 1·0, 1·2, 1·4, 1·6, 1·8, 2·0. The curves obtained for porosity and hardness are shown in the accompanying figures. Two porosity curves taken more than half a year apart on different samples of the Cafferata Plaster were almost identical.

The addition of salts for the purpose of strengthening the plaster was next considered. On the whole, after various trials, it appeared that substances accelerating the rate of setting were not very satisfactory, since a mixture containing more than two parts of plaster to one of water could not be made up before setting occurred. Retarders, on the other hand, while not unduly lengthening the setting process, allow of a much greater percentage of plaster in the mixture, and secure greater strength thereby.

The accompanying curves show the relation between porosity, crushing and tensile strengths and Brinell hardness of plasters, and the composition of the mixtures used, the liquid employed being a 1% solution of borax. Mixtures were made varying in steps of 0·2 parts by weight of plaster to one part by weight of water as before, but in this series the mixtures ranged from 1·8 to 3·0 parts of plaster to 1 of water.

The Brinell tests were taken with a steel ball of 20 mm. diameter, and a load of 100 kilos. The usual cement tester was used for measurement of the tensile strengths, the load being applied at the rate of 500 lb. per square inch per minute. In measuring the apparent volume for the porosity curves, cones of the material were turned on a lathe, and after being weighed in air, were immersed in mercury and the upthrust counterbalanced : they were then soaked in water in an evacuated vessel, and finally weighed wet in a closed vessel to prevent evaporation.

In Figs. 1 and 2 which show the porosity and diameter of Brinell impressions, two curves are given, the upper curve being that for plasters made up with the 1% borax solution, the lower that for plaster and water only. In Fig. 3 crushing-strength curves are given (for comparison) of plaster with the addition of a solution of potassium nitrate, of plaster and water with two different treatments in drying, and of plaster made with a 1% borax solution. In Fig. 4, the average tensile strengths of 12 specimens of plasters

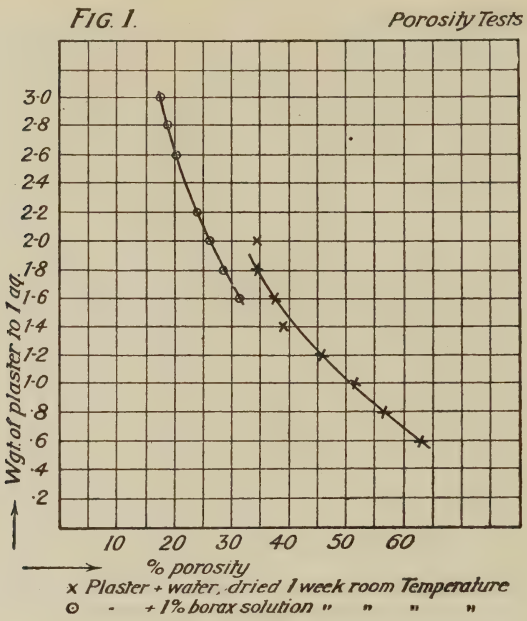


FIG. 1.
Porosity Tests
3·0
2·8
2·6
2·4
2·2
2·0
1·8
1·6
1·4
1·2
1·0
·8
·6
·4
·2
Wgt. of plaster to 1 aq.
10 20 30 40 50 60
% porosity
x Plaster + water, dried 1 week room Temperature
⊙ - + 1% borax solution " " " "

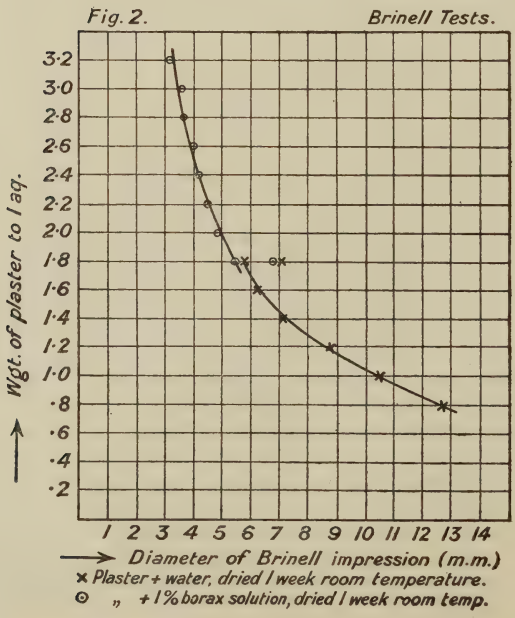


Fig. 2.
Brinell Tests.
3·2
3·0
2·8
2·6
2·4
2·2
2·0
1·8
1·6
1·4
1·2
1·0
·8
·6
·4
·2
Wgt. of plaster to 1 aq.
1 2 3 4 5 6 7 8 9 10 11 12 13 14
Diameter of Brinell impression (m.m.)
x Plaster + water, dried 1 week room temperature.
⊙ " + 1% borax solution, dried 1 week room temp.

Fig. 3. Crushing Tests.

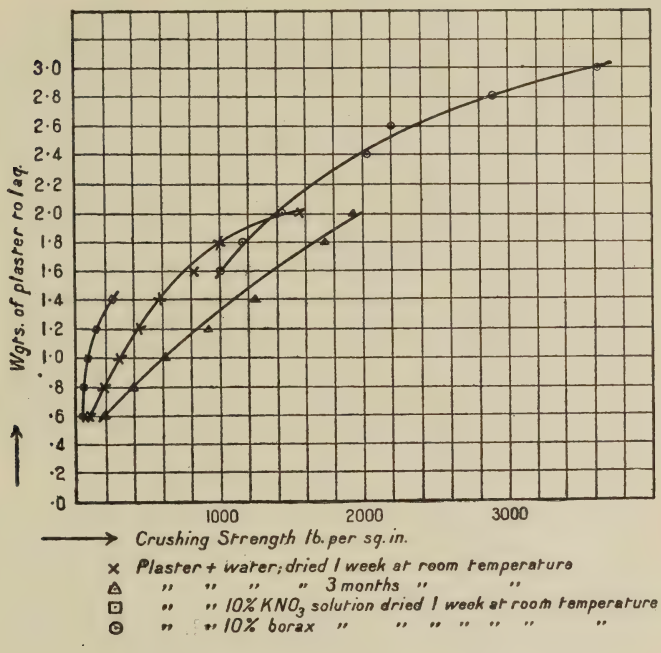
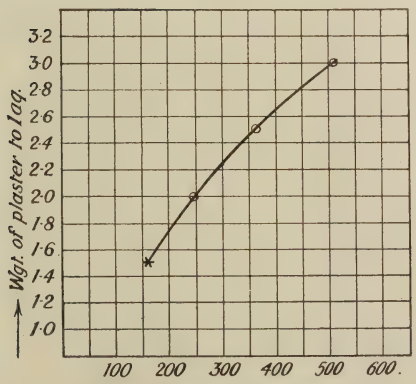


FIG. 4 Tensile Tests



Tensile Strength lb. per sq. in.
(load applied at rate of 300 lb. per sq. in. per min.)
Average for 12 specimens of each composition.

made with borax solution are plotted. One point (*i.e.*, 1·5 plaster) is that given by 12 briquettes made up with water only.

It will be seen that the addition of the 1% borax solution, by retarding the action of setting, allows of the preparation of plasters which cannot be prepared otherwise and that the strengths of these plasters are roughly in a continuous curve with the strengths of those mixtures made with water only. There is a slight shift, however, towards a greater strength, which is noticeable in Fig. 2, in which the two separate dots indicate the average of 10 impressions taken on a second set of specimens of compositions 1·8 plaster to 1 aq. This shift is the same as that shown in the curves themselves, and was an unmistakable one. It seems that the tensile and crushing tests were not sensitive enough to show this difference.

Mixtures containing 2·6—3·0 of plaster to 1 aq. plus 1% borax are of an almost plastic consistency, and can be moulded by hand. It will be seen from the curves that both the crushing and tensile strength of a 3·0 briquette is 4-5 times as great as that of the usual moulding mixture, which contains about 1·5 plaster to 1 aq.

Suction Tests.

In casting under pressure, the capillary action of the pores is enhanced by the effect of the difference of pressure between the inside and outside of the mould. This effect is uniform all over the mould, whatever the thickness, since the friction of the escaping air is negligible in comparison with that of the travelling water, but this only holds until the thinnest part of the wall is saturated. When this occurs, these parts will give less resistance to the out-going water and here greater deposition of clay will ensue. It has been found that it is better to work with moulds which nowhere reach saturation.

A mould for use in casting should not have less than a certain limit in suction power. The rate of absorption, depending roughly upon the porosity, is still more influenced by the grading of the holes. In order to compare suction power with porosity, the authors decided to carry out a series of tests on the suction of moulds: (*a*) due to capillary action alone, (*b*) under a definite applied pressure. Moulds containing 1, 1·4, 1·6, 1·8 by weight of plaster to 1 aq. and 1·8, 2·2, 2·8, 3·0, by weight of plaster to 1 part of borax solution were made up. They were of standard size with a hollow cylinder in the centre of depth $1\frac{1}{4}''$, diameter, $1''$, thickness of wall $1''$. The experiments were carried out after the moulds had been air-dried for about a week and were constant in weight.

For the suction tests without applied pressure, the weighed moulds were placed beneath a burette, and filled very rapidly with water while the tap of the burette was adjusted to keep the level of the water stationary at the top of the mould for a definite time period. The water was then quickly poured off, the moulds were weighed and the amount of water absorbed noted. The curves

FIG. 5.

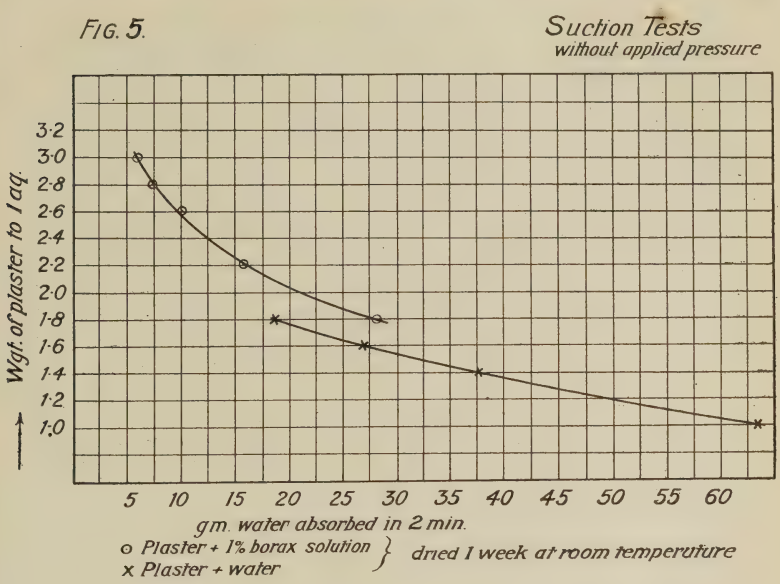
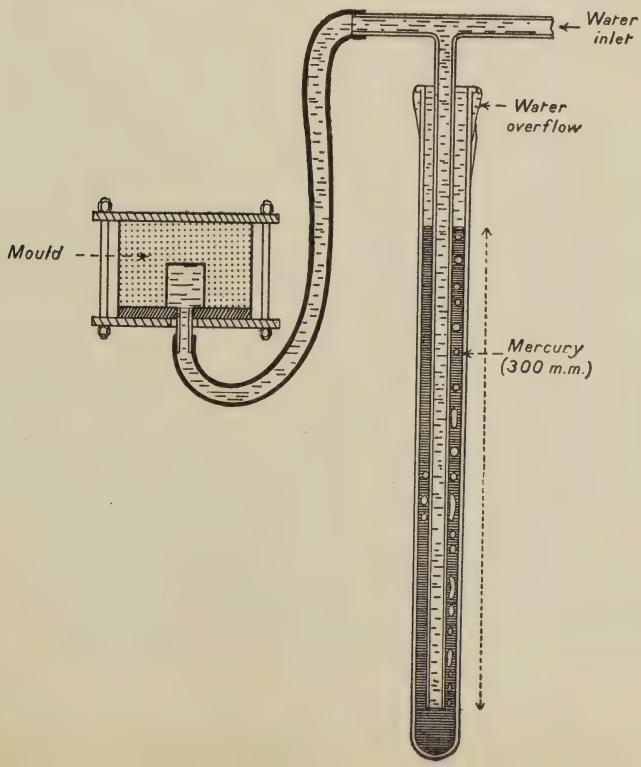

Suction Tests
without applied pressure
Wgt. of plaster to 1 aq.
3·2
3·0
2·8
2·6
2·4
2·2
2·0
1·8
1·6
1·4
1·2
1·0
5 10 15 20 25 30 35 40 45 50 55 60
gm. water absorbed in 2 min.
o Plaster + 1% borax solution
x Plaster + water
dried 1 week at room temperature

Fig. 6.


Water inlet
Water overflow
Mould
Mercury (300 m.m.)

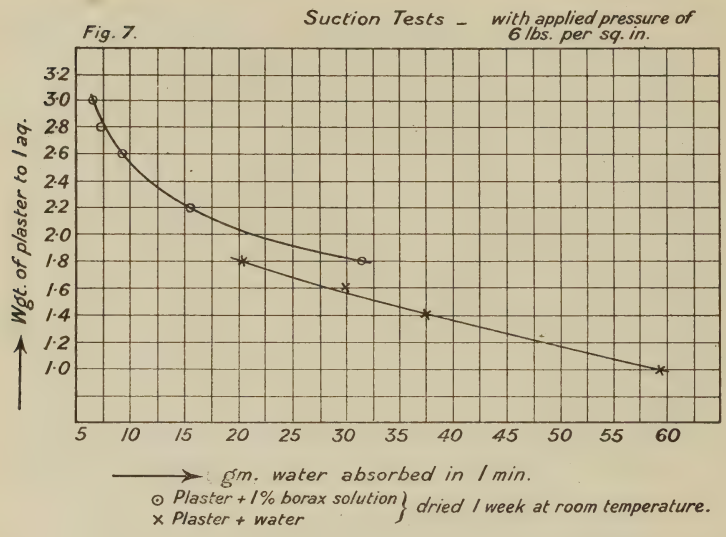


Fig. 7.
Suction Tests – with applied pressure of 6 lbs. per sq. in.
Wgt. of plaster to 1 aq.
3·2
3·0
2·8
2·6
2·4
2·2
2·0
1·8
1·6
1·4
1·2
1·0
5 10 15 20 25 30 35 40 45 50 55 60
gm. water absorbed in 1 min.
⊙ Plaster + 1% borax solution
× Plaster + water
dried 1 week at room temperature.

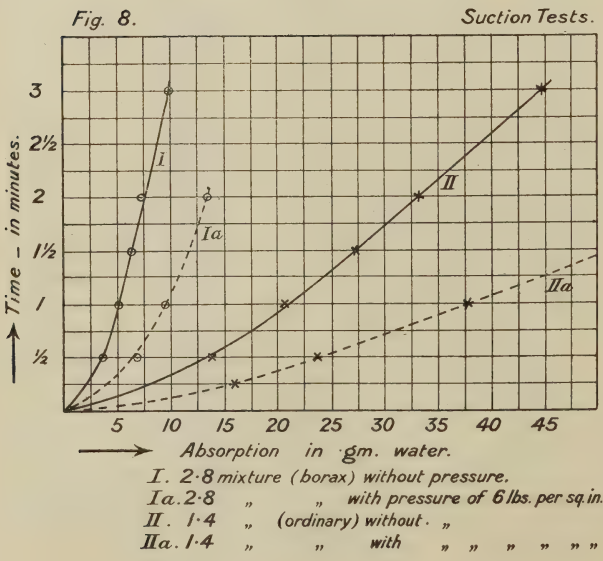


Fig. 8.
Suction Tests.
Time – in minutes.
3
2½
2
1½
1
½
I
Ia
II
IIa
5 10 15 20 25 30 35 40 45
Absorption in gm. water.
I. 2·8 mixture (borax) without pressure.
Ia. 2·8 „ „ with pressure of 6 lbs. per sq. in.
II. 1·4 „ (ordinary) without „
IIa. 1·4 „ „ with „ „ „ „ „ „

obtained for a period of 2 minutes for both borax and ordinary plaster are shown in Fig. 5.

For the suction tests under pressure the same moulds were dried out and subjected to the action of water under a pressure equal to 300 mm. of mercury (6 lbs. per sq. inch). The apparatus used is sketched in the diagram Fig. 6. The authors are indebted to Dr. G. Barr for a suggestion as to a simple method of obtaining a flow of liquid at constant pressure, based on the Mariotte principle.

The time taken to drive all air out of the mould and to fill it with water may be taken as negligible. Absorption curves (1 min. duration) for both borax plaster and ordinary plaster are shown in Fig. 7. It will be noticed in both cases that the absorption of 1·8 borax plaster moulds was greater than that of the 1·8 ordinary plaster moulds while there is a shift if anything in the opposite direction in their porosity curves.

Fig. 8 shows two time-absorption curves taken for two mixtures of composition 2·8 borax plaster and 1·4 ordinary plaster. These compositions are chosen because they represent the general working range of the plasters for mould purposes. Similar curves for the intermediate mixtures would lie in between curves I. and IIa. It was found impossible to use the same moulds again and again after drying, therefore several moulds were correlated as to suction by being given 1 minute to absorb water without pressure. They were found to differ very little in gain of weight. After being thoroughly dried and weighed one was then subjected to ½ minute, one to 1½ and one to 2, and one to 3 minutes filling with water and then weighed, and the results averaged and plotted.

In the case of a rod of porous material which is in contact with water at its base only, the distance of penetration of the water in a given time is proportional to the sq. root of the time. In these experiments a cylindrical hole was filled with water. During absorption, the area of suction was gradually increasing (to a larger extent also at the base of the mould) and therefore the curves given spread out as the time increases, instead of approaching the parabolic form. Yet they are useful for purposes of comparison. For example, a mould of 2·0 borax plaster has a suction just under three times as great as that of the 2·8 borax plaster without applied pressure (see Fig. 5). By comparing Figs. 7 and 8, we see that it has, under an applied pressure of 6 lbs. per sq. inch, a suction equal to that of the 1·4 plaster without applied pressure (*i.e.*, 21 g. of water absorbed after one minute). It has twice the tensile strength, and where a mould of that composition (1·4) might stand a pressure of 15 lbs. per sq. inch without reinforcement, this (2·0) could stand double that strain without breaking.

The authors have not yet been able to pursue these investigations in the many directions in which interesting results could be obtained. Reagents other than borax have their possibilities from a strengthening point of view. A stronger borax solution might

possibly increase the shift in the hardness curves and give a stronger body for the same porosity. But enough has been done to show the relations existing between the porosity, hardness and suction power of different compositions of plaster and to point out the effect of the addition of borax in producing plasters of great tensile strength. This should be of practical use for casting under pressure and also for other purposes.

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VIII.—Some Notes on Saggars.

By B. J. Moore.

I PROPOSE this evening to put before you the experience I have had in the use of two refractory materials for saggar making; namely, carborundum and fused silica.

In making my experiments I have worked on the theory that it was equally as important to use correct marl or fireclay for saggar making as it was to introduce the best form of grog, and so regarding china clay as a typical fireclay of a standard and pure type, and ball clay as giving the plastic properties to enable saggars to be made and in some cases to form the flux in a saggar so that it can be handled when fired without undue risk of breakage, you will note that I have gone away from the usual orthodox marls and substituted for these, mixtures of ball and china clays. Therefore, if any better results have been obtained with saggars containing quartz or carborundum, whatever credit is due to the introduction of this clay mixture must be taken into account. As a matter of fact I consider the correct introduction of a suitable marl or clay essential to the successful use of either carborundum or quartz for saggar making. This can only be obtained in practice and must necessarily vary with the fire temperature.

Some time last year, a firm of Carborundum Manufacturers wrote to several Pottery Firms stating that the saggar problem had been solved in the carborundum saggar. It seemed almost too good to be true, saggars lasted ten to twenty times as long as ordinary clay saggars, they showed fuel economy, great strength, resistance to wear, etc., economy was guaranteed.

I am afraid the Firm in question rather worked on the supposition of the man, who, having found a medicine which cured him of a certain ailment immediately jumped to the conclusion that this was an infallible cure for the particular disease.

I made some fairly extensive tests with saggars supplied by the Firm in question, and with saggars made by ourselves under working conditions, and the following were the conclusions I arrived at regarding the use of carborundum for saggar making.

There is no doubt that carborundum has very distinct advantages over the ordinary grog used in saggar marl, namely, broken up saggars, if used with a suitable saggar marl or clay so far as regards lasting qualities. The selection of a suitable marl is a somewhat difficult proposition, since marls vary so much from time to time. It would appear necessary to test the carborundum with samples taken from the bulk of marl it is intended to use, before deciding as to its suitability.

I think that there is little doubt that carborundum in saggars exerts a slowly reducing effect, and if marls are used containing iron pyrites excessive boiling takes place in the saggars causing subsequently iron contamination in the sand or flint used for placing the ware.

There are signs, too, when using carborundum for china saggars, of reducing having taken place inside the saggars, due to its use, causing discolouration in the china ware.

After numerous experiments I came to the conclusion that the best clay to use in conjunction with carborundum was a mixture of Dorset ball clay and china clay, and the proportion I have used with success for a temperature of Seger cone 9 was three of china clay, one of ball clay. With lower temperatures it is necessary to increase the ball clay and proportionately decrease the china clay, so as to obtain a saggar of sufficient stability to withstand the normal handling when placing, etc.

Then again, I do not think a hard and fast rule can be laid down as to the most suitable proportion of carborundum to introduce.

I have obtained excellent results with 60% of carborundum and 40% of clay (three of china clay with one of ball clay). Saggars made from this mixture have been in use for many months, 30 to 40 fires have been recorded.

The final throwing out of these saggars has almost infallibly occurred through—

(*a*) Small cracks which developed in the first fire becoming enlarged.

(*b*) Rough handling, causing breakage.

It would seem probable that the small cracks were caused through uneven drying or uneven firing originally, such as takes place in a pottery oven, particularly at the top of a down draught oven. It was at the period of my experiments with carborundum, when, in spite of difficulties and certain disappointments that had taken place in preliminary trials, I decided to give it a more practical and extensive test; in fact, my idea was to fill an oven with carborundum saggars and really test these against an oven full of clay saggars. To calculate the amount of carborundum necessary I roughly estimated a biscuit oven of saggars at 40 tons weight, and I considered 50% of carborundum a satisfactory basis to work on, or call it 25 tons for the oven.

I wrote for a provisional price for this material. £56 per ton, or something like £1,400 for the grog used to make an oven full of saggars, sounded to me rather a tall order, and eliminating other risks such as reducing effects, etc., I could not even concoct a report which would show a satisfactory return for the capital investment.

It was at this stage too, that Dr. Mellor suggested that fused quartz might have similar properties for saggar making as carborundum, and comparing the price of this with that of carborundum, it seemed to offer a very distinct advantage worthy of a careful

trial. The conditions existing on a Pottery do not in my opinion justify the adoption of carborundum for general use in saggar making :—

(1) Because of its high cost.
(2) It exerts a somewhat reducing effect in use.
(3) The difficulties involved in obtaining a perfect saggar the first fire are almost beyond solution in everyday practice, and this is essential if long-lasting, satisfactory saggars are to be made.
(4) Equally good, if not better, results can be obtained when substituting fused quartz for carborundum at a relative cost about one-twentieth that of the latter material, and this exerts no reducing effect in firing and can be used with any form of marl or clay.

I have no data to give regarding the use of carborundum for other refractories, but I am of opinion that if it will withstand the action of flue gases, etc., it will prove a high and valuable refractory agent in the manufacture of certain fire bricks, particularly for use where the latter have to withstand an abnormal pressure at a high temperature.

I now propose to confine the remainder of my remarks to the substitution of quartz in place of carborundum for saggar making.

I obtained about 10 tons of this material at a cost of about 50/- per ton, and I have now used up most of this.

I made my trials on a fairly large scale so as to eliminate data built up on purely experimental grounds, which is very often erroneous on account of circumstances taking place which would not do so under practical conditions.

If I were to record the results of all my trials with fused quartz as they actually appeared, I am afraid the results would not be conclusive proof that there was any advantage in its use, and it has only been by repeating negative as well as positive tests that I have arrived at results which I feel will show a very distinct saving in practice.

I do not want to take up your time unnecessarily, but in case anyone is tempted to make trials on the lines I have indicated, I would say "Do not be surprised at early failures." All your trial saggars will be a different size to those you have regularly in use, generally they will be larger ; placers will want to give them a good test and perhaps, having satisfied themselves that they do not melt the first fire, will set your pet trial, on which you are basing your hopes, at the bottom of a bung, with anything up to a ton weight on top of it. Do not be surprised, therefore, if you are told that there is a bung down and that your saggar let it down.

On careful investigation, you may find that your saggar was 1″ larger than the one above it, although the rest of the bung nested satisfactorily, in which case the strain would be a direct outward instead of a downward pressure.

In case it is any encouragement to others to follow up these experiments, I might mention that I have already data shewing that under the conditions existing at our factory, we can produce saggars made up of mixtures on the lines I have indicated which will last at least 20 fires in the china biscuit oven, 30 to 40 fires in the earthenware biscuit oven, 15 to 20 fires in the earthenware glost. As regards biscuit saggars, I am of opinion that the saving in obtaining cleaner ware from the ovens, due to the almost entire absence of iron in the saggars, will in itself more than compensate any factory for the extra cost of china or ball clay used in the manufacture of the saggars.

I know that speckless ware can be produced under certain firing conditions even with sand slightly contaminated with iron, the majority of which is introduced into the sand through repeated contact with dirty saggars. The conditions necessary for such results are difficult to obtain in practice.

By eliminating the source of the trouble, the presence of iron specks in body or sand, you will find that you can rest with an easier conscience and not worry so much as to whether your fireman is giving the correct amount of air to the oven at critical periods. There is one other remark I feel I should make before describing the few saggars I have here this evening, and that is, if you introduce long-lasting saggars for glost ware, care must be taken to see that these are regularly recoated with saggarwash, say every five or six fires. I have seen faults from old saggars, apparently well glazed, attributed to sucking. You have all, no doubt, seen similar results with saggars washed with a glaze containing a too low percentage of lead ; I suppose there comes a time when lead vapour ceases to be given off.

In conclusion, do not allow your head saggarmaker to mix the saggar marl, pay the junior clerk or anyone uninterested in this to do it to your instructions. No-one, I think, weighs out the materials for saggar making to the nearest place in decimals, very often it is a case of barrowfuls or boxes full. The personal element is so strong, that if left to the maker to do the mixing, the top weight will invariably go to the plastic clay and the smallest grog, or you may even find that some of the latter is left out altogether. I do know this, that if I were called on to make saggars, I should not want to use the mixtures that the saggars I am shewing here are made of. I feel sure that some of you may want to know the size of grog that I have employed. This I am unable to give you. I have done my experiments with a very old fashioned type of saggar making plant, consisting of only a solid edge runner pan. The method of mixing is to put in the pan first the shords or material to form the grog, and when this appears to be sufficiently ground, to add the clay, and continue the grinding until a homogeneous mixture is obtained.

Some time ago I had under consideration the installation of a

modern saggar making plant, but on enquiry at one or two factories who were using the so-called modern plant, consisting of a kind of pug into which the dry grog and clay were weighed and water thrown on to this, I felt disappointed with the results they were obtaining, and could not see that this gave really efficient mixing. I therefore decided to go ahead for the time being with our old solid pan and try to obtain more data as to what I considered a suitable up-to-date plant.

I am quite sure that better results still could be obtained if the grog was suitably graded, but I think it more essential still to have some form of light solid pan to mix the clay and grog together, so as to obtain an absolutely homogeneous mixture.

To summarise my results :—

Generally I found it more economical to substitute mixtures of ball and china clays for local marls or fireclays.

The percentage of china clay to be used depends almost entirely on the fire temperature.

The addition of fused quartz up to 50 or 60%, renders saggars almost proof against dunting, due to rapid cooling or heating, if added to suitable clay mixtures.

The better the materials used are mixed, the longer the saggars will last. I therefore consider it necessary to mix the clay and grog together on some form of pan. I do not think it sufficient simply to pass the materials through a mixer or pug.

The saggars I am shewing here this evening are composed of mixtures as follows :—

Saggar A. 3 of china Clay,
1 ,, ball, ,,
50% of grog.

This saggar has had some six or eight fires at Seger cone 9. It contains about 35% fused quartz derived from the grog used.

Saggar B. 3 of china clay,
1 ,, ball ,,
50% fused quartz.

This saggar is one of a batch made up in April this year. It has now had some 20 fires up to Seger cone 9 (China Biscuit).

The few iron specks visible inside the saggar have not been caused through impurities in the materials used, but from other outside causes.

Saggar C. 3 of china clay,
1 ,, ball ,,
50% grog.

This is an earthenware biscuit saggar, and is one of a batch made up in June last. I modified this mixture in July to—

1 of ball clay,
1 ,, china ,,
50% grog.

You will note, however, how clean this saggar is after repeated

fires. It has now had some 12 to 14 fires.

Saggar D. This is a glost saggar made up of—

50% of a local marl,
50% ,, common grog,
20% ,, fused quartz.

I am almost ashamed to show you this saggar, as I do not consider it a suitable mixture for regular use, but it illustrates well, I think, the non-dunting properties which the addition of quartz gives to the saggars.

I made up a small number of these saggars at the end of March last. On examination after the first fire, I found they had universally developed small cracks, which have since become enlarged, but not a single saggar has actually been broken up. They have stood at least 30 fires under very drastic conditions.

The "clemmings" are pulled down almost immediately the oven is fired so as to obtain the maximum cooling effect. They are fairly large ovens, 18′ 6″, and are seldom cooled for more than one clear day.

Saggars E. The two saggars marked "*E*" are samples of our new standard glost saggar, made up of—

50% of ball clay,
25% ,, china biscuit grog,
25% ,, fused quartz.

This may still need some slight modification in practice, but it is the general mixing I am adopting for glost saggars pro temp.

You will note that all the saggars here containing quartz have a "dead" ring, whereas the clay saggars ring comparatively well. This is characteristic of saggars containing quartz and appears to be almost an essential property to the production of a satisfactory non-dunting saggar. By this I mean that saggars which ring well and contain fused quartz invariably dunt more readily than those with a "dead" ring.

DISCUSSION.

Mr. Ashley Myott:—I am sure that Major Moore has given us food for thought for many days to come. If I may be permitted to start off the discussion, do I understand that each one of the saggars which he has displayed is considered to have had a fair treatment in the ovens?

Major Moore:—They have had no special treatment. If anything, I should say that they have had rather worse treatment than the ordinary saggars would have had. In many cases my special saggars were of somewhat different sizes to those in general use, and on more than one occasion I have seen my saggar nested at the bottom of a glost oven bung with the upper saggar nearly

inside it. The placers have had to prop it with wad clay to make it fit.

Mr. C. Bailey:—I have been more than ordinarily interested in listening to this paper. Major Moore started off by referring to the opinion that was expressed a year ago by a Carborundum Co. that the whole saggar problem was settled. I may say that I, also, in 1914, made some saggars which I thought had solved the whole business. I had vision of scrapping the whole of our saggar-making plant, and turning the place into additional potters' shops. I may tell you that I made saggars from carborundum which would have outlasted a thousand of our ordinary saggars. It seemed to me that once I had got my stock of carborundum saggars up to the necessary pitch, my saggar troubles would be ended. Unfortunately we were unable, after the outbreak of the war, to get carborundum at any price. Nowadays carborundum is again available, but we find it impossible to repeat the results which were previously obtained. Carborundum is a very variable material. Sometimes what is supplied to one as carborundum is really only carborundum sand. Carborundum is, as you all know, made by the fusion of carbon and silicon in an electrical furnace. Now the material which comes from the centre of the furnace is the real stuff; but any material which comes from the outer zones is nothing like so profitable in use. I have tested the carborundum sand, and it is practically of no use at all for saggar-making. The consequence is that experiments which have been carried out fairly fully on a dozen different factories by the committee of the Manufacturers' Federation, have revealed very contradictory results. Sometimes saggars are produced which look as though they would last a lifetime; others disrupt after about only two or three firings. One fact we have certainly proved, and that is that there is all the difference between using carborundum in an oxidizing atmosphere and using it in a reducing atmosphere. Major Moore has emphasised the trouble that is encountered with the carborundum in a reducing atmosphere. The experiments carried out in Burslem have been absolutely contrary to the experiments carried out in Longton, so far as the information before the Oven and Saggar Committee is concerned. The experience at Burslem is consistently good, whereas the experiments in Longton are consistently bad. The conclusion arrived at is that the variations are due to the fact that the biscuit ovens of Doulton & Co., Ltd., Burslem, are updraught and oxidising, whereas the ovens in the Longton district are downdraught and more reducing.

So far as fused silica is concerned, I quite agree with Major Moore, that if carborundum is effective—as we have proved it is—on the same basis fused silica should also be effective. On this basis of reasoning the Oven and Saggar Committee of the Manu-

facturers' Federation has been carrying on extensive trials, with results that have been very baffling. Major Moore speaks in his paper of fused quartz. This, of course, occurs only at a very high temperature, a temperature such as we are not going to reach in ordinary pottery firing. The consequence is that the results on factories which have been using this fused silica have been distinctly disappointing, the saggars having disrupted after a comparatively few firings. Dr. Mellor, the Committee's consultant, has been approached on this point, and he himself was at first rather baffled, although he soon came to the conclusion that the Committee was wrong in carrying out experiments at all with fused silica. He was of the opinion that silica should be experimented with in a tridymite form. The theory is that the fused silica must of necessity return to a tridymite form in a pottery oven, and that the tridymite form is in suitable equilibrium with the silica at pottery firing temperatures. Dr. Mellor's view on the matter is that the change ought not to occur inside the saggar, but should take place before the quartz is ground and mixed with the saggar. If you get this change taking place inside the saggar itself, the saggar will most surely disrupt. If, on the other hand, you can make this change before the silica is mixed with the saggar, then the saggar will remain sound, and have a decidedly good ring. This seems to be rather contrary to Major Moore's experience. In experiments which have been carried out by the Oven and Saggar Committee, the silica has been brought back, as suggested, to the tridymite form, and our latest results now look very promising indeed. I am sorry that the results of the most recent experiments are not yet available, but they certainly do look very promising. I would like to ask Major Moore whether his experiments have been entirely confined to the fused silica calcined at very high temperatures, or whether he is making further experiments with quartz re-calcined in order to bring it back to the tridymite form. If Major Moore has done this, and has any results to indicate on that basis, I should be extremely glad to know of them.

MAJOR MOORE:—I am afraid I am a little in the dark; but I am strongly of the opinion that there is no effect that we can give to the fused quartz at our temperatures—that is to say, up to cone 9—which is comparable to that which takes place at a temperature of cone 33. In the latter case you get quartz in an absolutely melted form. I am sure that whatever change takes place in the fused quartz at the temperature of our ovens can have little or nothing to do with the fact that some saggars containing fused quartz appear to go "rotten." In that case, it is the clay mixture that is at fault.

One almost invariably finds that saggars containing this material have a rather dull ring. My idea about that is that

instead of putting in a normal grog you are putting into the saggar something which neither moves one way nor the other. It has practically no expansion or contraction. If this material is put into the saggar in grains of a suitable size there is a kind of dovetailing with the clay by which the quartz is surrounded. I have here a saggar that has been in use since the first of April, and used at a comparatively high temperature. It has a dull sound; it has had that dull sound all along. My own opinion of that is that the clay in that saggar is more or less split to pieces and that if you could remove the pieces of fused quartz which are holding the clay together, the saggar would simply tumble to pieces. If this is not so, why should we not make the saggar satisfactorily with carbon and let it burn out? Saggars containing fused quartz possess an "elasticity" which you do not find associated with saggars of the ordinary kind.

MR. C. BAILEY:—Major Moore has been so frank and generous in his remarks that it inspires one with a desire to be equally open. I am quite prepared to say that a change does occur in this fused silica. Although you may use a quartz that has been fired to cone 33, a change takes place when we fire it in our ovens. The fused silica will go back to the tridymite form and this change is going to take place in the saggar itself with an unfortunate result. If the fused silica is calcined at the temperature at which you desire to fire the saggars, or if—better still—ordinary quartz is bought and calcined up to the temperature to which the potter proposes to fire his ovens, and then used as grog, the results will be more satisfactory.

MAJOR MOORE:—I would like to ask Mr. Bailey if he can give me any information as to how many fires are required to convert this quartz into a tridymite state at cone 9—ordinary china biscuit.

MR. BAILEY:—I do not know. But the saggars seem to disrupt and go tender, if not actually rotten, after 3, 4 or 5 fires. After that, no nature seems to be left in them.

MAJOR MOORE:—I could show Mr. Bailey dozens of saggars the prospective life of which I have estimated by their dull ring. If the saggar has practically no ring, I know it is going to last. If, on the other hand, it has a good ring, I know it is not going to last. I have here my standard saggars for china biscuit. Personally I do not care whether the quartz changes to a tridymite form or anything else, so long as it will last. In any case, I put before you here a saggar with a perfectly dull ring, and I am prepared to guarantee that it will not go down under ordinary conditions.

DR. SCOTT:—Fused silica does undergo a change if it be fired in a pottery oven, but the corresponding change of volume is slight. The specific gravity of fused silica is approximately 2·21,

of tridymite 2·28, and of cristobalite 2·33. If it be assumed that the silica changes to tridymite the calculated cubical change is 1·4 per cent. and the linear change 0·5 per cent. The corresponding figures for a conversion to cristobalite are 2·1 per cent, and 0·7 per cent. respectively. It must be noted that this change of volume is in each case a contraction, since the specific gravity of the fused silica is less than that of other varieties. The conversion, however, is seldom accompanied by the theoretical change of volume and in practice it is probable that the contraction would be less than the above; in fact there might even be a slight expansion if there was also an increase in the volume of the pore spaces.

According to Heraeus, fused silica, after being heated in a pottery oven, changes to a form with a specific gravity of 2·33 which is indicative of cristobalite rather than tridymite. Hence the expansion, if any, is likely to be very slight. The idea that the saggars have expanded, may have arisen from a comparison with fireclay saggars, which of course, have undergone considerable contraction.

Mr. Bailey:—Dr. Scott means, I take it, that fused silica does not change in a china biscuit oven to the tridymite form. That confirms my point that the saggars go rotten after three or four firings.

Dr. Scott:—I am inclined to think that cristobalite is the new form developed. Does Mr. Bailey consider that a change involving ·5 per cent. linear contraction (or even ·7 per cent.) is sufficient to cause a saggar to go rotten?

Mr. Bailey:—No; I should hardly have thought so.

Major Moore:—I have experienced to a considerable extent in my experiments the fault to which Mr. Bailey refers. As I understand it, he means that the saggars crumble up, break to pieces, and go rotten. There is no other word for it but "rotten." I have come across this fault, not only in my experiments with fused quartz, but also with carborundum and ordinary grog. It was for this reason that I said if I were to record the whole of my results with fused quartz I should not be able to give you any conclusive evidence that there is any good in it at all. I have traced the fault to the use of an unsuitable marl or clay along with the quartz. I am perfectly convinced that that is a frequent cause of the trouble. I said at the beginning of my paper that I consider it equally as important, if satisfactory saggars are to be produced, to have a right clay mixing to suit your own particular firing, as well as to introduce the best sort of grog, no matter whether you are using fused quartz, ordinary grog, or whatever else. I myself have had many saggars that have gone "rotten." I handed one or two saggars to another firm to fire. The report

I received was that they were no good at all; they crumbled up readily. It is only by modifying the clay mixings that I have arrived at satisfactory results which are borne out well in our works practice. All I can say about rotten saggars is that this particular china biscuit saggar which is before you has been in use since the first of April last, and has sustained from twenty to thirty firings. I do think that it is absolutely essential to get the right clay, and I suggest that the majority of the negative results which have been encountered with fused quartz have been due to the use of an unsuitable saggar marl.

Mr. H. L. Steele:—Can Mr. Bailey tell us what clays he has used along with his fused quartz?

Mr. Bailey:—I can only say that there have been a dozen firms experimenting, all using their own particular clays. Experiments have also been carried out with china clay and ball clay, no fireclay being used at all.

Mr. H. E. Wood:—I made some experiments sometime ago with fused silica, and my experience was that there was very much more expansion than Dr. Scott has led us to expect we might encounter. My saggars—made from fused silica, ball clay and china clay—have been fired about nine or ten times. They have no ring whatever, and they are very friable. This is due, to my mind, to the breaking down of the fused quartz. When Dr. Mellor made that suggestion of fused quartz I thought the whole question of saggar-making was solved. One would have thought that in using a material fused at cone 33 there were no further changes to come. To my astonishment we found that it broke up. It breaks up in the piece, and it breaks up in the saggars. This, to my mind, seems to be positive proof why the saggar loses its ring. You have a breaking up of the quartz and its conversion into something else. I am not in a position to say what that something is, but I know that the expansion that we got was something more than one per cent. Major Moore said that his saggars grew bigger and bigger, and that some of his losses were due to the fact that the experimental saggars were put at the bottom of the bung, and were so large that the other saggars went inside them.

Mr. Ashley Myott:—I did not understand Major Moore to say that his saggars grew bigger and bigger.

Mr. H. E. Wood:—To my mind there is something in the idea of using fused quartz for saggar-making. I would go so far as to say that I believe that there is a future for it. So, also, there is for carborundum. Successful results can, I feel sure, be got with carborundum, but we must have a better quality of carborundum. I have altogether about a thousand saggars. I am

using them in the first ring with china biscuit. I have had no reduction whatever, but I have had losses. I believe that a good many of the losses to which Mr. Moore has referred are due to bad practice in the Potteries. Sufficient time is not given to the saggars to dry. In my trials with carborundum we have had a good deal of trouble due to the fine cracking to which Major Moore has referred. The results of my investigations into this trouble have been to convince me that the fine cracks are there before the saggars go into the ovens at all. We rush the saggars, and dry them too quickly. In our new saggars I may say that we are using smaller grog. The body is denser, and the result is that the saggars would seem to require longer drying than the ordinary saggars which we previously made. My conviction is that ordinarily in the Potteries, saggars do not get the proper treatment in the making and drying that they deserve.

Mr. Myott:—I am inclined to think that we are yet a long way from the solution of this problem, and that we should do well to have another discussion on the subject in the early future.

Major Moore:—I have little to add to my replies to the discussion on this paper, and generally my expression of opinion regarding the function of fused quartz in a saggar mixture is the same. I have still saggars in use in the china biscuit oven which were made in February, 1920. They have sustained some 60 or 70 fires.

I don't think there is any justfication at all for the assumption that fused quartz, in reverting to a tridymite form or to some different state or other after one or more fires at our oven temperatures, causes saggars to disrupt. There is, however, some difficulty in making saggars successfully in the green state, and it is only with the use of certain clay mixtures that I have been able to obtain satisfactory results.

In proper proportions and with a suitable clay mixture, fused quartz will produce a highly refractory saggar, capable of withstanding considerable pressure at high temperatures, and lastly, a saggar that is particularly free from dunting through uneven heating or cooling.

Generally speaking, saggars containing fused quartz do not stand handling so well as those containing ordinary grog.

IX.—Question Box II.

1—*Question*—When coal used for the firing of glost ovens and enamel kilns contains considerably more pyrites than usual, what precautions should be taken when using this inferior fuel?

Mr. F. S. Worthington:—It is somewhat awkward to give a direct answer to this question for the reason that the member who sent in the question did not state what particular kind of ovens were in use—updraught or downdraught. Looking round, I also observe that there are so many gas experts present that I am afraid whatever remarks I may have to make will be considered rather out of date. However, I will give you my opinion for what it is worth.

There is no doubt that, during the war, many manufacturers' managers had to make use of fuels varying very widely in quality. Some were good, whilst others could only be effectively described by the special adjectives of an oddman or fireman. With a glost oven I think that the best thing to do under such conditions of irregularity in fuel supplies is, first of all, not to bait the oven too high, and allow plenty of air. An important point is not to bait the mouths too full. Often one sees the fireman going round with his baiting poker, and ramming in more fuel. The result is that the backs of the mouths become choked with fuel, and an ooster forms which blocks up the flues and makes it impossible to get up the heat. I think the right thing to do is to bait oftener and lighter. By this means the ooster forms at the front of the firemouth, and by pulling out the glut bricks it is very much easier to extract it. I strongly recommend that before each baiting the fireman should go round and get out the softer ooster, as this will enable him to keep the fires clear all the time and bring out a successful oven. Another point worthy of consideration is that when you are dealing with two qualities of fuel on a works it is far better, although I know it hardly sounds right, to use the best quality first. By this means you get the mouths hotter and the oven warmer and you are better able in the end to burn up the inferior fuel. As a general rule the fuel is burned in the reverse order—the worst first, and the best kept for the finish. In my experience that is not the best practice.

When dealing with enamel kilns there are two points to which special attention should be paid. It is not necessary, of course, to fire so long as with a glost oven; therefore the best thing to do is to save as much heat as you possibly can, and keep the mouths clear. It is my opinion that the back and front flues of the ordinary

four-mouth kiln should be very much bigger than the middle flues, because, as we all know, the back and the front of the kiln are always the coolest parts and take longer to fire up. It is a waste of time and fuel to keep the second and third mouths of the kiln waiting for the back and front. This also helps to develop any tendency there might be in the body towards "spit-out" ware, for about 99% of the loss in this fault comes from the middle of the kiln. I also think that the back and front flues should open on the fire side, which gives a bigger pull underneath the kiln and over the top. With the middle flues I think it is just as well to have them opening on the top of the kiln, in which case the top does not become so hot and you do not run quite so much risk of "spit out" ware. I made some experiments, in the direction of lining the front of the kiln—the iron door—with asbestos between the iron and the brick work. It was surprising the difference that this made to the getting up of the front of the kiln. The kiln door is now very much cooler than it used to be ; you can put your hand on it, whereas previously you would have been badly burned if you had attempted to do so. As for the mouths, I think that a nice height for the flue from the bars would be about 10 inches. This allows plenty of room to admit the fuel without the mouth becoming choked by the ooster. In this way it is possible to fire quite as successfully with inferior fuel as you are able to do with the best. I have noticed frequently that an enamel kiln has come out with less loss when fired with poor coal than when fired with the best.

2—*Question*—What is the cause of the blibbing on the majolica tiles exhibited ?

Mr. PERRY:—I do not like to attribute faults, particularly glaze faults, to certain definite causes, unless I am well acquainted with the conditions under which the faulty article has been produced. It is quite possible that my remarks may be all wrong in relation to these particular tiles, but I can only speak of my own experience of a similar fault. I will pass round the faulty tiles submitted.

Personally, I have never encountered this fault, except when I have been dealing with glazes high in boric acid, with a view, particularly, of producing opalescent glazes. In such a case, with a certain fire, I always get it. , What actually causes the blibs, I do not know. The glaze is certainly very fluid at this temperature (Bar 15—16), although if you fire much harder (Bar 19—20) the blibs disappear again. In conducting a number of experiments I found that by reducing the boric acid, the fault was obviated. Also by increasing the silica the fault may be removed. But the two methods in combination removed it quicker. When there is no other base present than lead, which is very often the case in glazes of this type, the fault is certainly much more pronounced

than it would be were one to replace a little of the lead with whiting or soda. China Clay will not remove the fault : it simply makes it worse, and even though you fire to Bar 19—20, the blibs will not disappear when china clay is added.

Even at the lower temperature the glaze is very fluid, so it cannot be said that the fault is due to the glaze not being properly matured. I take it that the borosilicates which are formed at that temperature, or at a still lower temperature, are very unstable, and as the temperature increases, silica is taken up from the body, and a certain amount of B_2O_3 is liberated ; being somewhat volatile at a red heat, and an excess being present, some of this B_2O_3 escapes through the glaze.

Leadless glazes will stand a good deal of boric acid with a small silica content, without showing these blibs, but if the silica be high at the same time blibs appear even at a low temperature.

If this blibbing is a general fault of the glaze I should say the best thing to do would be to harden it. If, on the other hand, it only comes under certain conditions, then I should have to review the whole proposition. Personally, I have only met with the fault in glazes that are high in B_2O_3. I have certainly never met with it in any commercial glaze with any variation within reason. The glaze with which I experimented had two molecular proportions of B_2O_3 which was very high.

I do not know what are the conditions under which these faulty tiles have been produced, what the composition of the glaze is, to what heat they have been fired, or any other of the conditions, so it is almost impossible to say for sure, what has caused the fault in this particular case. What is certain is that glazes such as I have mentioned, give this fault regularly. It is certainly quite an uncommon fault in ordinary majolica glazes, and it seems to me that it has nothing whatever to do with the ordinary conditions that are met with in dealing with majolica kilns.

Mr. Bernard Moore:—The fault is a very common one. I have met with it dozens of times in glazes that contain no boric acid whatever. I have met with it in dealing with ordinary lead glazes —in fact with all kinds of glazes. I can quite imagine that certain boric acid glazes would be more inclined to show the fault than some others. I think that it is due to sulphur vapours in the kiln, which are absorbed by the glaze, and that if you have a glaze which skins over at the high temperature the sulphur vapours bubble out. In a great many cases, if you have a glaze that remains porous for a time sometimes the sulphates will come out without producing these particular blibs, but if you have a glaze which skins over early, and the sulphates are enclosed in the glaze, faults will be produced similar to the one submitted. I think that the remarks made by Mr. Worthington in connection with the firing of ovens and kilns are applicable to this fault, and that the trouble is often caused by baiting the mouths when they are too hot. A pres-

sure is set up in the flues and the gases pass into the kiln. A similar effect is sometimes produced when the saggars are not well washed, or when a crank in which the tiles are placed is porous. I take the explanation to be that every glaze has a certain capacity for holding sulphates without blistering. When the glaze becomes more acid through feeding on the body and the lead volatilising you may have blisters formed. A similar fault is experienced sometimes with ordinary earthenware, when the saggar is badly washed or insufficiently lead-washed. If the lead volatilises and the glaze becomes more acid through using up the base lead, the capacity of the glaze to hold the sulphates becomes less and blistering ensues. That is my opinion.

Mr. Perry:—I have seen every kind of blistering that Mr. Moore has mentioned. I have seen it due to different raw materials in the glaze, both in soft glazes which begin to fuse before the gases are evolved, and when it has been due undoubtedly to gases in the kiln which have been absorbed at a low temperature and thrown out afterwards. I have also seen the fault when it has been due to unwashed cranks or saggars. These types of blistering, in every case, have been different from the one now under review. This particular type of blibbing is unique. Only in the boric acid glazes have I myself seen it. I have seen it in dealing with vases which have been dipped in a glaze high in boric acid in order to produce certain special effects. It is encountered particularly when the glaze runs towards the foot of the piece and becomes thicker in that region. It has not the appearance of a broken blister. The edges of the bubble itself are quite rounded off. I do not think that the fault is due in any way to sulphur oxide in the latter part of the firing.

Mr. Dogar Singh:—I have seen blistering several times in glazes without any borax, and I am of the opinion that it is due to sulphur. Full particulars are given in Dr. Mellor's "Collected Papers," where he discusses faults in glazes, and also in Seger, volume II., where he discusses the question of sulphur, and how it comes about in both body and glaze materials, as well as suggesting remedies. I think Mr. Bernard Moore is quite right, and that the trouble is due to sulphur. It has also been found that the trouble can arise through hydrocarbons and carbons absorbed in the glaze during firing (see Dr. Mellor's "Collected Papers,") and is also sometimes due to moisture absorbed by the body in the storehouse. Last week I encountered this blistering in connection with manganese and cobalt colours. The fault in this case appears to be due to oxygen absorbed by the colours during the earlier stages of the firing, and given off at the higher temperature. In the same cranks we had tiles that were blistered and tiles that were not. Upon breaking the tiles we found that there was a certain black mark in the

centre of the body. The mark was not distinctly visible, but on close examination as light shading of carbon was perceptible in the centre of the tile. We sent certain biscuit tiles into the stove to dry them off again before dipping, and with this precaution the fault was not encountered.

Mr. B. J. ALLEN:—It might be of some interest to mention that similar blibs occur in leadless glazes on fireclay bodies fired to quite a high temperature, say 1250°—1300° Cent. I remember a period when there was an epidemic of this sort of thing, and it was traced to soluble sulphates in the clay. By washing these off the surface of the clay piece before glazing the trouble was eliminated. If left on the surface, quite a group of blisters was produced, similar to the tile which has been shown to us, but ten times worse.

3—*Question*—Now and again we experience curling back and cracking of the edges of flatware. By what means can this be avoided ?

Mr. W. EMERY:—Whenever possible, questions relating to faulty ware should be accompanied by actual specimens, otherwise the answers are of necessity restatements of well-known facts, whereas an inspection of the goods might indicate that the defect was due to abnormal causes. The successful production of jollied flat ware depends on many factors of which the more important are : Well prepared clay, true jigger heads, speed easily regulated, accurate moulds, design of profile (special attention is required as regards the angle or bevel), setting of the tool to ensure standardization, skilled workmen, and suitable stoves to obtain even drying.

Variations from these conditions are always likely to increase the quantity of seconds. Flat tools, though not actually in contact with the edge of the mould, are there subjected to greater pressure than in any other portion. As a result the profile will wear away quickly at that particular point. Lack of attention as regards filing up and adjustment is a frequent cause of cracked edges, and is probably a contributory factor in the curling back. No doubt all these points will have received attention from the management concerned, and this leads me to a consideration of the method of making. A careful examination of the seconds in the warehouse will indicate whether the faults are common to all makers ; if not, narrow the enquiry down to the worst of the Staff and study each phase of the making operation.

The preparation of the bat receives scant attention, but in "Bone China" at any rate, a good bat properly applied to the mould is an important consideration.

If a platemaker applies irregular pressure or unevenly distributes the water used during the making operations, then unequal

density and construction may be reasonably expected. In practice, there is less pressure put on the extreme edge than say on the ball, and that portion of the rim nearest the ball, and if this irregularity is accompanied by a lack of water in the same section of the plate, the edge will dry quicker and will be free to move while the remaining portion of the article remains rigid. Lateral movement is restricted, consequently there will be a tendency for the plate to move vertically away from the edge, thus giving the curling back referred to. Under similar conditions one would expect cracked edges also.

Mr. WORTHINGTON:—I think the chief cause of the curling back and cracking of the edges of flatware is attributable to the tool filer. You will often find, where there are many cracked edges, that the tools are made of iron. With a well-filed steel tool it is possible to eliminate the loss practically entirely. I was not quite clear as to what Mr. Emery wished to convey when speaking of the pressure at the edge of the plate. A flat presser, when he throws his plate on, very rarely starts from the centre in running down. Most of the pressure which he applies is upon the edge. Then also one has to consider where the moisture is applied in the working of the plate. You do not see the maker put it on the centre, but nearly always on the rim, so that I think that the edge has as much lubrication, and that is not the principal cause. I also think that the pressure on the edge is as much as, if not greater than, that in the centre. I have always traced this fault to iron tools not being properly filed. An iron tool ought to be filed after every 50 dozens. If the maker goes on longer than that without the tool being refiled, he is sure to experience the curling of the plate, whereas a good steel tool will always last four or five days without being touched up, and the curling is not experienced. Some of these curls cause a crack in clay and sometimes a crack in firing. I firmly believe that most of the cracks could be found in the clay if one were to search for them.

4—*Question*—Is the sounding of a piece of pottery a logical test of its degree of firing?

Mr. MYOTT:—Does not Dr. Mellor think that there are so many variations in bodies that one cannot avoid that it would be impossible to keep a body on any works sufficiently constant, having regard to the grinding of your slop materials and other points, to test the firing satisfactorily by sounding?

Dr. MELLOR:—I confess that my own ear for sounds is deplorably weak. I can only recognise two classes of tunes. One is that

in which you want to keep time with your foot and the other that in which you do not want to do so.

Mr. WORTHINGTON:—There are two plates on the table. One is fired in the biscuit oven and the other in the glost. Which of the two sounds of those plates would you take as being correct? There are likewise two plates which are both fired together. Which would you say is easy fired?

Mr. HEATH:—But you have there a difference in the composition of the body to contend with.

Mr. C. BAILEY:—The point before us is one which I have endeavoured to go into rather closely because I make a grade of goods that is very much summed up by my customers according to its sound. I have, however, had the extraordinary experience of taking one wedge of clay from a pug, making two dozen plates with it, firing them in exactly the same saggar, and then finding all sorts of differences in the sound. The suggestion that a difference in the composition of the body would alter the sound is admitted; but it is also necessary to remember that any irregularity in the making up of the body, any difference of shape and so forth, would materially change the note of the ring. You will also find that a flat rimmed plate will always sound a trifle dead, whereas the more dished shaped it is the higher the note.

Mr. DUNBAR BISHOP:—If you compare the same articles you will get appreciable differences. I think the one thing that has not been pointed out up to the present is that the pitch of the note may vary with the amount of the firing, but it also varies inversely with the thickness of the piece.

Mr. HEATH:—Would not every plate in the bung sound a different note? One of the biggest things to contradict the theory of testing firing by sounding is, I think, the treatment the plate receives in the making—what pressure it receives at the hands of the makers. Then again, if a plate is pressed it will give a different ring from a plate that is jolleyed.

Mr. C. D. GRIMWADE:—I suppose that the first thing one does, almost by instinct, on testing a piece of ware from the oven, is to sound it, but the problem is clearly a good deal more involved than it appears at first sight. If you get a good many shapes of earthenware in the same saggar you will discover almost every note that you might think of, even though the pieces are fired to the same degree of temperature. I have noticed that in sets of things—sets of jugs of the same shape—whereas all the same sizes give practically the same pitch, the larger the jug the lower the note. This is the only regular feature that I have been able to discover in the sounding of the ware.

Dr. MELLOR:—There is some analogy surely between Mr. Grimwade's point and the determination of the sizes of organ pipes.

X.—An Elutriation Test for Potters.

By B. Moore.

IN the making of sound earthenware, nothing is of greater importance than that the materials should be suitably ground. I think that it is probably more important than the quality of the material that is used. It is essential, therefore, that we should have some method of knowing whether the materials used are ground in a suitable manner. Owing to manufacturing conditions and the almost universal practice of measuring a body in slop state, it is practically impossible to keep large stocks, and it is therefore all the more necessary that we should be able to obtain this knowledge quickly.

The object of this paper is to show how a sample of flint can be examined by anyone who will work carefully, in 4 or 5 hours, during which time the operator will only have to give a few minutes attention. In the past, very small samples have been taken for elutriation, and everyone has recognised the difficulty of taking a fair small sample. I propose to take a sample of at least a pint. I need not explain to an audience like this, the principle on which elutriation is based; I will simply point out that the quicker the flow of the liquid, the larger the diameter of the particle which is carried by the stream. Schöne has shown that for materials with a specific gravity 2·65, D equals $\cdot 0314 \times V^{0\cdot 636}$ the velocity being expressed in millimetres per second. I have drawn my graph to correspond with this. I feel that the work will sometimes be done by men or women to whom the expression millimetres per second does not convey very much, and I append a table which gives a velocity in inches per minute. The elutriator which I show (see Fig. 1), has a straight side in the middle, and has an internal diameter of $6\frac{5}{8}$ inches. This gives an area of 34·47 inches. A pint contains 34·6 cubic inches. It follows, therefore, that if you run a pint of water per minute into this elutriator, the flow in that part of it will be at the rate of 1″ per minute. I shall show you later how this can easily be converted into millimetres per second.

The top portion of the elutriator is gradually wider; this is simply to act as a kind of safety valve to prevent rough particles being carried over if the flow of water is accidentally increased or if there has been careless stirring. You will observe that there is a hole into which a small cork is fitted, which enables you to draw off this water at any time. This, of course, empties the top portion of the elutriator, and when the cork is replaced it enables you to run the water in very quickly, and in this way thoroughly stir and mix up any sediment without danger. Care must of course be taken to stop the violent flow before it reaches the top.

The water flows into the elutriator through a funnel, the

bottom part of which is kept about 1 inch from the bottom. I have found it very convenient to use a funnel which will allow 3 or 4 times as much water to run through it as I require, and to lessen this flow by having a loose glass rod inserted in it, which contracts the opening so as to allow the exact flow which is required. The amount of this flow must be taken when the elutriator is working, as it depends both on the size of the opening and on the height of the water in the funnel above the water in the elutriator. If this observation is taken when the funnel is full of water, the amount of flow cannot increase; even if more water comes through the tap it will simply flow over the top of the funnel into the top of the elutriator. Care must however be exercised, when the amount of water going through is being taken, to see that none is passing over the funnel.

If we knew accurately how a particular sample was graded, it would only be necessary to make one determination and this would give us the percentage of each fraction. In the past, it has been assumed that the grading is regular with an equal percentage of each fraction, and the diameter has been calculated with this assumption.

For example: a sample with the limits ·01 — ·06 m.m. is assumed to contain equal weights of ·01, ·02, ·03, ·04, ·05, ·06 and the average diameter has been calculated on that assumption.

You are aware that certain figures are generally added to an elutriation report giving the so-called surface factor. This figure is obtained by multiplying by a number which varies with the mean diameter, the smaller the mean diameter of the given fraction, the greater the multiple.

I am of opinion that the mean diameter of the very fine fraction, which is less than ·01 mm. and which is estimated to be ·0063 mm., which is the most important one, is about right, and that the multiple 359 which is used is also about right. With regard to the other fraction, if my conclusions are right, the mean diameter, which is now assumed is very much too large, and the multiple used, namely 53·9 much too small, this would be about 90, and the surface factor figure which you have seen in the past would be increased by about 20 in normally ground pottery material.

Dr. Mellor pointed out some years ago that if we knew the law of continuity of the sizes of the different particles we could perhaps determine the true mean, but that we can approximate closer and closer to the reality by multiplying the number of fractions. I have endeavoured to find out what the grading is for normally well ground pottery material. It is startlingly different from even grading, and the grading will vary with the amount of grinding, the proportion of fine fraction continually increasing and the rough fraction continually decreasing. I have endeavoured to show this in a graph.

If you have a material containing 10 different fractions, with

equal weights of each fraction in it, say ·01, ·02, ·03, ·04, ·05, ·06, ·07, ·08, ·09, ·10. If each fraction was crushed once, and then the process repeated a second time, it might be thought that the fraction was still evenly graded. This is not so however, if we apply definite numbers to the fraction. For example the result of the first crushing would give us a material with 40% ·02 and under, and 40% ·04 and under, the remaining 20% being ·04 and over. When this had been crushed a second time, it would give a fraction with 40% ·01 and under and 40% between ·01 and ·02 that is 80% smaller than ·02, 20% larger than ·02.

Now this is more or less what happens in pottery grinding. We know that we want 40% to 50% of the ·01 fraction, and I commenced by drawing a graph, which showed 50% finer than ·01 of a millimetre, the upper limit being ·06 of a millimetre. If I can find out how to divide the line between ·01 and ·06 the problem would be solved. This division follows the reasoning I used in the last example; I put figure 2 half way between ·1 and ·6 and 3 half way between ·2 and ·6. The graph I show is based on this assumption and I find that it agrees very closely indeed when tested empirically.

I also show a graph on the board in which $D=V^{0.636}$ multiplied by ·0314. V represents the velocity in millimetres per second. The figure ·0314 is correct for a material with a specific gravity of 2·65 and this figure will vary with the specific gravity of the material that is being examined. I have put one other curve on the graph, calculated for a specific gravity of 2·4. Although this has been shown very clearly by Dr. Mellor, it does not appear to have been realised what an enormous difference it makes in actual practice.

The sample with a specific gravity of 2·2 is a sample of ground felspar, which when elutriated a month or two ago, gave the highest surface factor I had ever come across in ordinary practice. 80% was returned as less than ·01 of a millimetre. This was a great puzzle to me as I had much evidence to show that it had not been particularly finely ground. I had a chat with Dr. Mellor on the subject, as felspar is not often elutriated and we wondered if some solution had taken place which made the fraction come over in a different way. I now find some evidence to show that the specific gravity would be about 2·22 and if you look at the graph which I show, the whole question is satisfactorily solved. The fraction wichh was carried over at the velocity of 180 milimetres, instead of being ·01, was ·015. This would of course make an enormous difference, as the extra amount carried over would be weighted by the high figure which is used. It would mean that instead of a surface factor of 325, it would be in the neighbourhood of 210. In the same way if calcined flint is being elutriated which has a specific gravity of 2·4, a very great error is introduced.

With the help of Graph No. 3, the diameter can be easily

calculated for any specific gravity. Calcined flint is generally about 2·4 and the two curves plotted on this graph show what an enormous difference there is between 2·4 and 2·65. The diameter of the fine fraction instead of being ·01 is ·013. In my opinion an elutriation report should in every case give the specific gravity of the fraction carried over.

Velocity M.M. per Second	Inches per minute	D. in M.M.	Lawn
·200	·47	·0114	1100
·250	·59	·0130	
·300	·70	·0146	
.350	·82	·0161	
·400	·94	·0175	800
.450	1·06	·0189	
·500	1·18	·0202	
·550	1·29	·0215	
·600	1·41	·0227	
·650	1·53	·0239	
·700	1·65	·0250	500
·750	1·77	·0261	
·800	1·88	·0272	
·850	2·00	·0283	
·900	2·12	·0292	
·950	2·24	·0304	400
·221	·52	·0120	

Table for materials with a specific gravity of 2·65.

DISCUSSION.

Dr. J. W. Mellor:—In a paper published in the *Transactions* some years ago, I examined the assumptions on which the surface factor is based; and, by a modification in the method of calculating the average diameters, how to make the whole argument consistent. This does not however make the argument sound; there is of course a difference between consistency and soundness. For example, we assume that the fine particles are spheroidal. A sphere has a minimum surface area for a given quantity of solid; and by assuming the particles are spheres our results represent minimum values. We also assume the sizes in the different fractions are evenly graded. I showed that this is probably wrong.

After stating the difficulties involved in assuming the uniformity of grading of the fraction, I showed that our knowledge did not enable us to go further and that the assumed law of grading must be wrong. I further stated that Mr. Heath and I intended to follow it up. The removal of the Laboratory to the Central School of Science and the War prevented us following up the subject further.

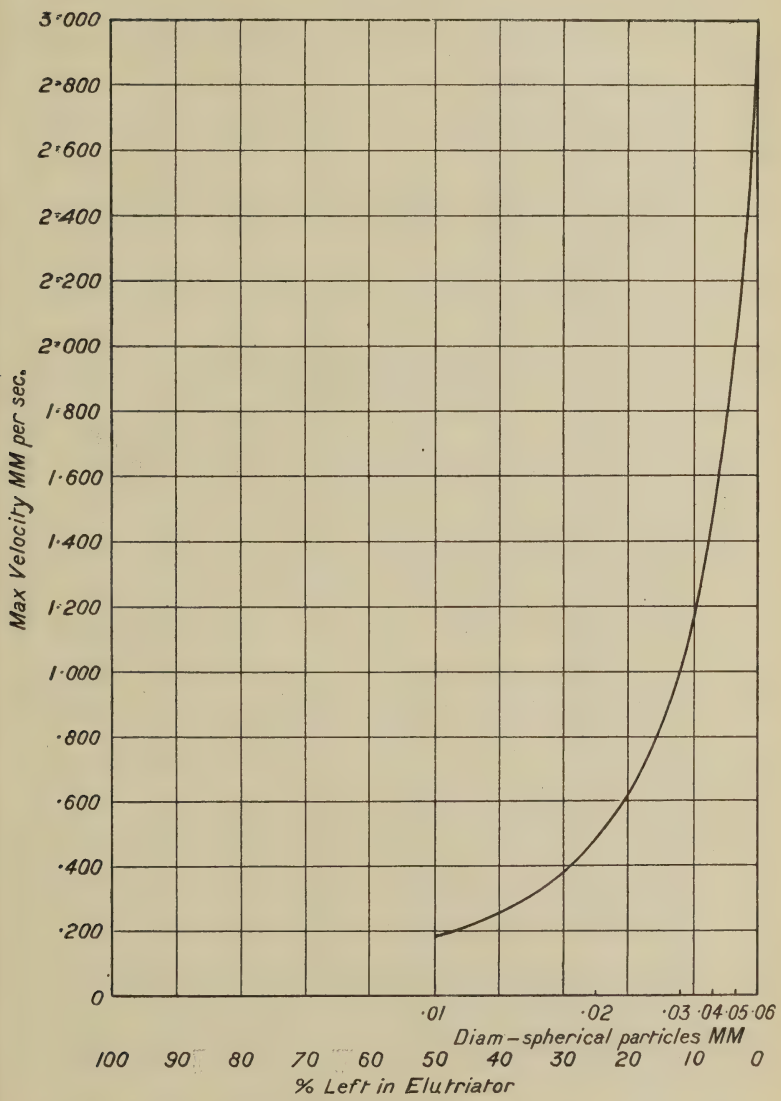
When we do know the law of grading for any particular material, and for any particular system of grading, given one fraction, the units of any or all other fractions can be calculated.

A third assumption made is that sp.gr. of the material is 2·6.

I showed that a large error is introduced when the sp.gr. is altered. The different calcination of flints effects the result quite markedly. I showed further that to some extent these errors balance one another. I was very pleased when Mr. Moore took up this subject, and have been delighted with the progress made. I should like to congratulate him too on his ingenious elutriator for works' use.

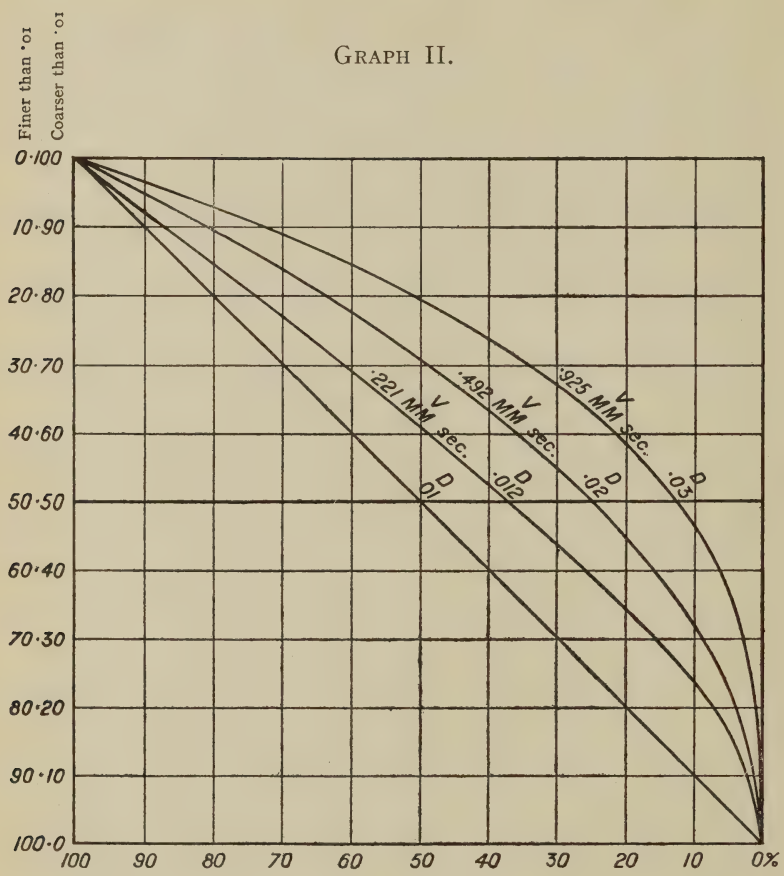
Mr. A. HEATH:—To me Mr. Moore's paper has been very interesting. I would, however, rather like an opportunity of studying the machine a little more closely. The great thing in elutriation is that we elutriate to find out the percentage of a certain fraction. If we take that as ·01 of a millimetre—which is the very finest fraction—it takes an enormous length of time ; but in practice I find that where we have a certain percentage of that fraction we have invariably a definite percentage of the next one, which is run off at what we call on the manometer 5 cm, which gives particles between ·01 and ·025. These could be run off in two hours comfortably, and if we could be sure that this 5 cm. fraction regularly had a corresponding proportion of ·01 cm. fraction, the one test would be as good as the other. In practice, when I am doing tests for anyone, I use both these fractions because to my mind the one is not sufficient. In this case it does not matter how we reckon the surface factor providing it is something in correspondence. If the surface factor of the 1 cm. was, say, 200, that of the 5 cm. would be 35. You may have in all the rest of the fractions and average them out at 20. But we want to know what causes crazing. The main point of elutriation tests is to keep away from crazing. I have a set opinion that all above one certain fraction—·50 cm. on the gauge—causes crazing. If, then, we get far enough removed from that, we are all right. On the assumption of 200 as the surface factor for the 1 cm., 50 is the surface factor of 14. I always say that we should have 45 per cent. of the 1 cm. fraction and not less than 25 per cent. of the 5. That gives 70 in all. I have put the surface factor down just for this purpose. I have averaged it at 140. We can then average all the rest. The remaining 30 per cent. gives an average of 20. This gives us a surface factor of 1040. On that assumption 14 crazes and 200 dunts. I have got my surface factor to 104. I was going to suggest that 70 per cent. of the 5 cm. fraction and 30 per cent. of the balance would give a body suitable for general earthenware. Sanitary potters like their material a little coarser than that. I want to study the thing some time along with Mr. Moore, because I have doubts as to the settling, although I know that he says he takes the cork out and stirs up the liquid. I do not want to offer any criticism at all. To my mind the apparatus looks easily workable and practically foolproof, whereas with the other apparatus one has to be very careful indeed.

GRAPH I.



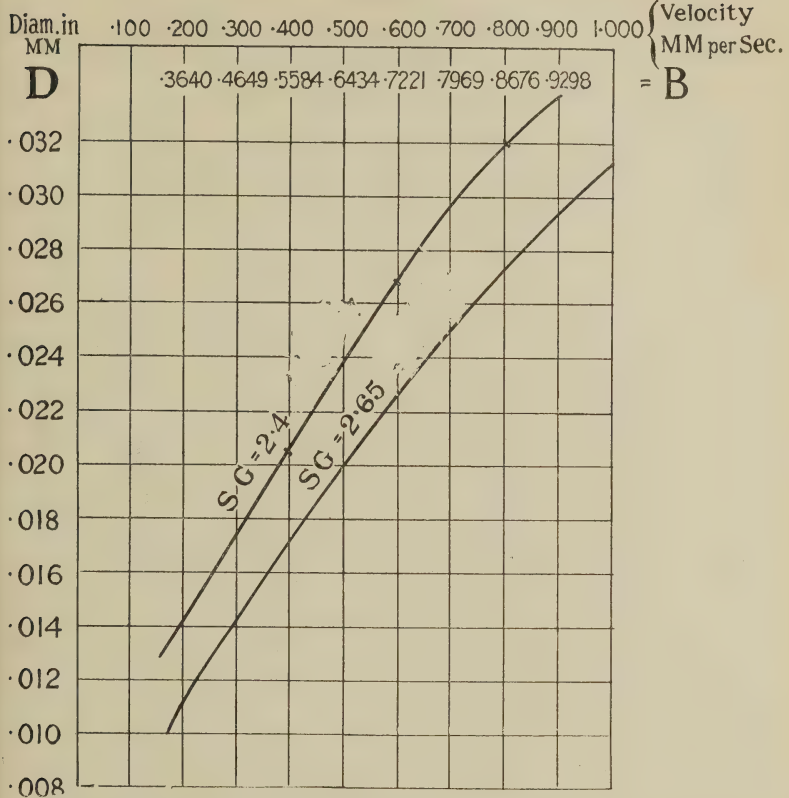
Curve showing percentage of different grades of fine material left in the Elutriator with different velocities.

GRAPH II.



Graphs for the determination of the proportion of different mixtures carried over by streams with velocities ·221, ·492 and ·925 respectively. The vertical lines give the amounts of coarse and fine, the horizontal the percentages left in the elutriator.

GRAPH III



In Schöne's formula $D = 0{\cdot}0518\,V^{0{\cdot}636}/(S-1)$ let $B = D(S-1)/0{\cdot}0518$, so that $B = V^{0{\cdot}0636}$

This involves a separate graph for each value of S when the variables are D and V. Consequently, for any value of the specific gravity S, the graph enables the diameter D of the particles corresponding with any velocity V, to be seen at a glance. (Ed.)

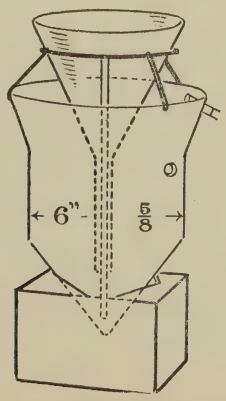


Fig. 1

Sketch of Elutriator.
Diameter = $6\frac{5}{8}''$ Scale $\frac{1}{8}''$ to $1''$

XI.—A Note on Thorpe's Solubility Ratio.

COMMUNICATION FROM THE CLAY AND POTTERY LABORATORY, STOKE-ON-TRENT.—No. 99.

BY J. W. MELLOR.

IN the well-known solubility ratio for lead frits, where the solubility in dilute hydrochloric acid under certain standard conditions is taken to indicate the toxic properties of the frit, T. E. Thorpe proposed an empirical rule which gives a very fair indication whether a frit is likely to have a low solubility.

T. E. Thorpe's rule is:—

$$\frac{\text{Sum of bases (including alumina)} \times 223}{\text{Sum of acids} \times 60} = 1{\cdot}45 \text{ (better 2)}$$

where molecular proportions (bases unity) are understood. Thorpe's ratio can thus be broken into two factors:

$$\frac{\text{Sum of bases (including alumina)}}{\text{Sum of acids}} \times \frac{223}{60} = 2$$

With certain limitations as to the alumina and boric oxide, the rule agrees fairly well with observation. The purpose of this note is to point out that the multiplication by the factor $223 \div 60$ is a blemish, and has no raison d'être. The rule should read:—

$$\frac{\text{Sum of bases (including alumina)}}{\text{Sum of acids}} = 0{\cdot}5 \text{ nearly.}$$

The appearance of precision imparted by selecting the molecular weights of lead oxide and silica is quite illusory. The rule obviously means that if the ratio be less than 0·5, the frit will probably have a low solubility. Thorpe's suggestion that the number be multiplied by the mol. wt. of lead oxide and divided by the mol. wt. of silica is quite arbitrary; the ratio of the numbers of my house and of the first taxi we meet would do quite as well. There is no need to disfigure an excellent empirical rule with an appearance of profundity which is utterly without justification.

XII.—The Effect of Calcination of Flints on Earthenware Bodies.

COMMUNICATION FROM THE CLAY AND POTTERY LABORATORY, STOKE-ON-TRENT.—No. 98.

By A. HEATH AND A. LEESE.

THE object of these few notes is to show the effect produced by the variation in calcination of flints on an ordinary earthenware body. Much has been written on the various changes taking place during the calcination of flint, how it changes to tridymite and on to cristobalite. But to the average potter these various names represent nothing. He knows that he has always used calcined flint in his body and he presumes he always must use it.

If, however, he is told that by *not* knowing the effect of the calcination he is running a risk of crazing, his attention is roused. He regards with incredulity, for instance, the fact that it is possible to get six or seven per cent. more or less flint in his body than is required, owing solely to the degree of calcination. His contention is, that if he uses a specified number of pecks or inches, and the weight per pint is constant, he cannot be wrong. But he may be wrong. It has been pointed out many times that during calcination the specific gravity of flint is changed, and according to the degree of calcination, will vary from about 2·6 to 2·2. The simple result of this to the potter is that *one pint of slop flint weighing* 32 *ounces may vary in actual dry contents as much as* 12·8 *per cent.* Does the potter think that such a difference would have no effect on his body?

Up to a few years ago this point of variation in specific gravity was not of so much importance as it is at the present time. Formerly millers had time to keep big stocks of materials in arks, so that even if the calcination of different kilns varied, the mixing in the arks kept a fair average maintained. But to-day, the miller is pushed, and the result is that he is sending his flint out straight from the wash-tub, so that if there is any variation in the calcination of different kilns, that variation is passed on to the potter. The question then is, does the variation exist and does it affect the body to any appreciable extent? This is what we set out to investigate, and we submit the result of our work to you to-night.

We have no idea of the temperature reached in the ordinary flint kiln, and we venture to say that on that point we are as wise

as the average miller.

We therefore calcined one lot in the "hardening-on kiln" and the other in a biscuit oven. The resulting specific gravities of the flints were :—

Hard calcined	2·312
Easy ,, ...	2·481

From these results it will be seen that if we have one pint of slop flint at 32 ozs., the amount of dry material will vary as follows :

Hard calcined	21·146
Easy ,, ...	20·102

which, as you will see, is a difference of 5·1 per cent.

The method for ascertaining the dry contents is the one usually adopted, viz. :—Brongniart's formula :

$$\text{Dry contents} = \frac{\text{weight per pint} - 20}{\text{sp. gr.} - 1} \times \text{sp. gr.}$$

as explained in Jackson's "Ceramic Calculations" and also in Vol. 14 of the *Trans. Cer. Soc.* But the difference is certainly startling. On the face of it, it means that if a manufacturer has a body that is only just inside the safety line from crazing when using the hard variety, and he happens to get the easy variety, he is puzzled to know why his body crazes. Similarly, if his body is compounded to be as far as possible from risk of crazing when using the easy variety, and he happens to get the hard variety, he is up against the risk of peeling. The question of what should be the recognised specific gravity standard depends on the original compounding of the body.

We made up a batch of body using each variety, and slop weights for all materials, and fired the plates in the same saggars. We have here some plates of each. No differences were noticed in making or drying, and the loss on drawing biscuit was the same in each case. But the size of the plates is different :

Hard contracts 4 per cent.
Easy contracts 5 ,,

This is, of course, accounted for by the fact that the hard actually contains more flint. A nice point, however, arises as to whether the easy should not (during firing and consequent changes of its specific gravity) expand sufficiently to neutralize the difference in quantity.

The ring of the ware also had a distinct difference :

Porosity is :	hard calcined ..	20·09%
	easy ,, ..	17·83%

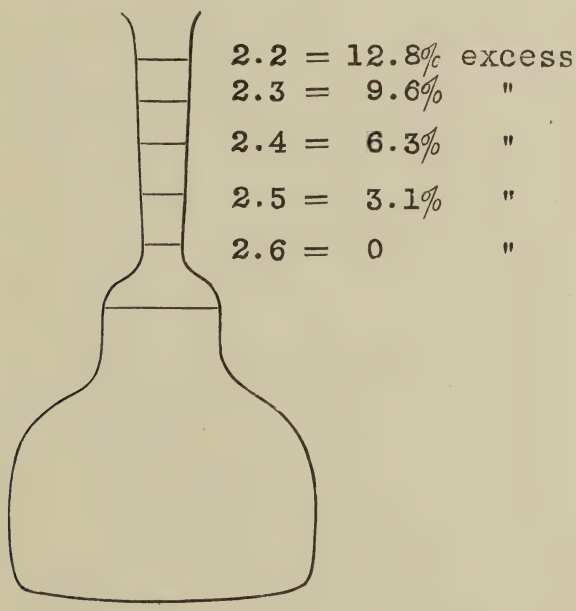
On drawing from the glost oven none showed signs of crazing. We have here six plates of each variety that have been exposed to the weather outside for 10 days, and no crazing took place. Three plates of each have also been in every-day use for a month, and none show crazing. On submitting to a recognised test for crazing, however, it was found that the easy went first.

Such is the result of our experiments, and our conclusions lead us to say that if a manufacturer wishes to be sure of running no risk of crazing epidemics, he would be wise to insist on knowing :

1st. The specific gravity of his flint,

2nd. The fineness of the same.

For this purpose it is essential that some ready means should be devised by which these properties can be quickly ascertained with fair accuracy for works use. We hope to show such a method for the first property, and we think in a very short time Mr. Bernard Moore will be able to give us a ready method for the second. Our method depends on the fact that: given equal weight of material of the same specific gravities and equal quantity of water the resultant slips will always occupy the same volume. Any variation is at once shown in a graduated tube and on reference to a table the amount of excess or shortage of dry material is at once seen :



FINENESS,

	Hard	Easy
Left on 200	0·87	0.01
Residue in Elutriator ..	10·67	11.01
5 cm.	28·52	30·73
1 cm.	59·93	58·22
	99·99	99·97

DISCUSSION.

Mr. C. D. Grimwade:—I would like to ask the lecturers whether they could enlighten me on the point as to why flints fired in a clear oven to about cone 3a exhibited a lovely turquoise. I have only once encountered this phenomenon, and a piece showing the effect is here produced.

Mr. A. Heath:—I think you will often find the same effect when whiting is burned, so that it almost looks as though the effect is due to chalk on the flint. I do not know what the chemists may think about it.

Mr. Ashley Myott:—Perhaps some of our friends who are particularly engaged in the milling section of the potting industry will be able to tell us what their idea is as to the degree of heat to which the calcining kiln is taken. The essayists, in the course of their paper, remarked: "We have no idea of the temperature reached in the ordinary flint kiln, and we venture to say that on that point we are as wise as the average miller." I feel sure there must be some millers present who would probably like to contest that point. I am afraid the statement will go by default unless we have some contradiction of it.

Mr. Bernard Moore:—I think that the point to which attention has been drawn by Messrs. Heath and Leese is a very important one. If you assume that you have the difference that is shown by them it means that you have a difference of about one per cent. of silica in the body. It does not mean very much more than that; but I think there is a very much more important point to which attention might be called, and that is, that the activity of the hard-fired flint is very much greater than that of the softer variety, so that I myself should expect to get an important difference even though the silica content of the body were kept constant. You have these two factors operating at the same time, and therefore you are running an additional risk of trouble. The essayists were quite correct when they pointed out that when dealing with easy-fired flint the silica content of the body is reduced by about one per cent. but the average amount of flint that is added to an earthenware body approaches $33\frac{1}{3}$ per cent., which would really mean a difference of 1·5 in the silica content of the body. If you are already on the border line of crazing the probability is that this slight difference might be sufficient of itself to pull you over the margin of safety, but I would point out that you have an additional factor at work which is assisting crazing, viz:—that a body made with uncalcined flint is more difficult to glaze—other things being equal—than a body made with flint which is well calcined. This has been shown pretty conclusively, and the fact has been known for a good many years. Where attempts have

been made to introduce silica into the body in the form of sand it has necessitated taking the ware to a very much higher biscuit fire. The uncalcined sand (quartz) is less likely to combine readily, and trouble is occassioned if the firing is not harder. Where, as on the Continent, it is the practice to use a good deal of sand, it is also the custom to take the biscuit firing to a much higher temperature. Certain experiments with which I was connected some few years ago on a fairly large scale illustrated this point. Probably some of you will remember that attempts were made to introduce into use a moorland stone from the Leek district. A good many people were fairly sanguine that this would replace to some extent the use of china stone and flint. I made up a number of different pottery bodies utilising this moorland stone, but leaving the silica content of the body the same, and with a few experimental plates, remarkably good results were obtained. These preliminary trials were very satisfactory, and the company that was connected with the stone wanted me to certify that it was suitable for use as china stone and calcined flint. I was not inclined to do that, because I did not feel that the results obtained with the few dozen trials made warranted any such certificate. I suggested that I should be allowed to run a factory with this material for a fortnight or three weeks, suggesting that I did not think there would be very much loss, and that if the firm would guarantee any possible loss, a test could be carried out on a thoroughly commercial scale. I was instructed to carry out the suggestion and went ahead. The resultant ware was very good-looking, quite as satisfactory as the previous ware so far as appearance was concerned, but the margin of crazing was very much reduced. The slightly easy-fired ware crazed. I felt very disappointed with the results, and suggested that if the stone were ground very much finer—if it were abnormally finely ground—the difficulty might be overcome to some extent. I received instructions to carry out this additional suggestion for a fortnight, and made up a body with excessively finely ground stone. The effect of this was that the crazing was overcome completely, but the loss on the big pieces was enormously increased through dunting, 10, 15 and 20 per cent. of loss being encountered in such articles as dishes from this particular fault. Careful records were made of the loss in the whole of the oven, for the reason that there was an arrangement by which we were entitled to claim for any extra loss. The final results showed that although the saving in the cost of the body was something like 3 per cent., the extra loss entailed amounted to 5 or 6 per cent. Eventually, therefore, I decided that the use of moorland stone was not likely to be of any practical benefit to the potters, and the matter fell through. The investigation to which I have referred seems to bear rather intimately upon the question that has been raised by Messrs. Heath and Leese, and I thought a statement of the position might be of interest in this connection.

Mr. A. Leese:—Would it not be wise to devise some standard method of calcining the flints?

Mr. Heath:—I am rather anxious to get the particulars about the temperature of the calcination of flints. At least I would like to know definitely whether they are fired as hard as an enamel kiln.

Mr. Podmore:—We will find out the temperature for you and communicate it later.

Mr. D. F. W. Bishop (communication read at next meeting):—Something was said at a recent meeting as to the temperature to which an ordinary flint kiln is fired for calcination purposes, but no one had any definite figures to give. Since then, I have made some trials, placing one of Buller's rings in a small setter (made of saggar marl) about 3 ft. below the top of a flint kiln. Another setter was placed over that containing the ring so as to preserve it. I found that the ring registered *eleven* on the gauge after the kiln was drawn.

I also tried a ring at the bottom of the same kiln and this was placed in a small saggar and covered over. This ring only registered *two* on the gauge.

ANNUAL CONGRESS AND EXHIBITION OF THE SOCIÉTÉ DE CHIMIE INDUSTRIELLE, PARIS.

We are requested by the Council of the above Society to call the attention of Members to the Annual Congress and Exhibition of Applied Chemistry, which are to be held in Paris in October next.

The first meeting, at which Monsieur Dior, Minister of Commerce will preside, is to take place at the Conservatoire des Arts et Métiers, at 9-30 a.m., on October 10th. Altogether, the meeting will comprise thirty-four technical sections corresponding to the various industrial applications of chemistry.

The Exhibition will be open from October 7th to 16th, and will include two sections : (1) Laboratory Equipment and Industrial Control ; (2) Dyestuffs.

PUBLICATIONS RECEIVED.

1. The Chemists' Year Book, 1920. *By* T. W. W. Atack and L. Whinyates. *Fifth Ed., Vol. I.*, Pp. 422; *Vol. II*. Pp. 1,136 (Manchester: Sherratt & Hughes, 1920), Price, 21s.

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2. Ceramic Industries Pocket Book. *By* A. B. Searle. (London: Sir Isaac Pitman & Sons, Ltd., 1920), Price, 8s. 6d.

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3. Silica and the Silicates. *By* J. A. Audley, Pp. XIV. and 374 (London: Baillière, Tindall & Cox, 1921). Price, 15s.

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4. Aide-Memoire du Chimiste Céramiste. *By* L. Franchet, Pp. 79. (Paris: Revue des Matériaux de Construction et de Travaux Publics, 1921).

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5. Abhandlungen über Steinzeug. Various Authors. Pp. XXIX and 144. (Coburg: Müller & Schmidt, 1920). Price, 8 mks. (plus export duty, etc.).
This is a collection of articles, dealing with stone-ware, which have already appeared in the *Sprechsaal*.

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6. Ueber Beziehungen zwischen Schwerschmelzbarkeit und Plastizität der Tone. *By* H. Rubinstein. Pp. 78. (Berlin: Verlag der *Tonindustrie-Zeitung*, 1919). Price, 5 mks. (plus export duty, etc.).

INDEX OF TRANSACTIONS AND PROCEEDINGS.

A

Absorbing Power of Calcium Sulphate Cement. A. B. Taylor and E. Irvine, 83
Allen, B. J.—Blibbing on a Majolica Tile, 109
— — — Crazing of Hard-fired Biscuit Earthenware, 56, 57
— — — Lead Silicate Frits often come from the Kiln dark and discoloured, 64
— — — Why does a Glaze containing Tin Oxide produce a Ruckled or Pimpled Surface when a slow-drying Fire is used ? 70
Annual Congress and Exhibition of the Société de Chimie Industrielle, Paris, 127
Art in the Pottery Industry. G. M. Forsyth, 2
— : Plea for Toleration in — J. W. Mellor, 11
— : Symposium on — 1
Atack, T. W. W., 127
Audley, J. A., 127

B

Bailey, C.—Is the Sounding of a Piece of Pottery a Logical Test of its Degree of Firing ? 111
— — Saggars, 99, 101, 102
— — Spanish and Portuguese Potteries, 80, 81, 82
Bakker, B. R., 83, 92
Bayliss, Wm.—Symposium on Gas Firing, 31
Barr, G., 91
Beavis, Dr.—Improvements in Swedish Potteries, 51
Bishop, D. F. W.—Crazing, 59, 60, 62, 63
— — — — Crazing of Hard-fired Biscuit Earthenware, 56, 57
— — — — Effect of Calcination of Flints on Earthenware Bodies, 126
— — — — Is the Sounding of a piece of Pottery a Logical Test of its Degree of Firing ? 111
— — — — Spanish and Portuguese Potteries, 80
— — — Why does a Glaze containing Tin Oxide produce a Ruckled or Pimpled Surface when a slow-dragging Fire is used ? 70
Bisque Ovens, 43
— Warehouse, 44
Blair, G.—Improvements in Swedish Potteries, 54
Blibbing : What is the cause of — on Majolica Tile ? 106
Boiler and Power House, 42
Brinell Tests, 85

C

Cafferata Plaster, 84
Calcination : Effect of — of Flints Earthenware Bodies. A. Heath a A. Leese, 121
Calcium Sulphate Cements : Porosi Strength and Absorbing Power — — — A. B. Taylor and E. Irvi 83
Calcott, J. A.—Crazing, 61
— — — Effect of Fine Ground or Ov ground Flint on Bodies, 67
Cast Pot : Cracking of — — whilst in t Clay State at the Seams where Joi in the Mould Occur, 66
Cements : Porosity, Strength and Abs bing Power of Calcium Sulphate A. B. Taylor and E. Irvine, 83
Chatelier, 83
Cleverley, Wm.—Lead Silicate Frits oft come from the Kiln Dark and D coloured, 63
Coal : What Precautions should be tak when Firing Glost Ovens and Ena Kilns with Inferior — ? 105
Conveyors, 50
Cracking of Cast Pots when in the Cl State at the Seams where Joints in t Mould occur, 66
— of Edges and Curling back of Flatwa 109
Crazing of Hard-fired Biscuit Earth ware more readily than Easy-fired,
— or Peeling of Quick Biscuit-fired Bo 58
Crushing Tests, 87

D

Desch, C. H., 83, 92
Design : Pottery — from Manufactur Point of View. H. J. Plant, 8
Dipping House, 44
Discoloration of Lead Silicate Frits wh taken from the Kiln, 63
Dunnachie, J.—Symposium on Gas-firi 27

E

Earthenware Bodies : Effect of Calci tion of Flints on — — A. Heath a A. Leese, 121

Elutriation Test for Potters. B. Moore, 112
Elutriator : Sketch of — 119
Emery, W.—Curling back and Cracking of the Edges of Flatware, 109
— — Improvements in Swedish Pottery, 55
— — Lead Silicate Frits often come from the Kiln Dark and Discoloured, 66

F

Faugeron Tunnel Oven, 74
Firing : Gas — E. W. Smith, 20
— : How is it that Biscuit Earthenware Crazes more by Hard — Than Easy — ? 56
— : Is the Sounding of a Piece of Pottery a Logical Test of its Degree of — ? 110
— of Glost Ovens : What Precautions should be taken when Using Inferior Fuel ? 105
— : Quick — of Biscuit Ware. Does the Glaze respond to Interior or Exterior of the Body ? 58
— : Why does a Glaze containing Tin Oxide produce a Ruckled or Pimpled Surface when a Slow-dragging Fire is used in the Final Stages of — 68
Flatware : How can Curling Back and Cracking of — be avoided ? W. Emery, 109
Flint : What is the Effect of Fine Ground — on Vitreous Earthenware, Semi-Porcelain and Earthenware Ivory Bodies ? 67
Flints : Effect of Calcination of — on Earthenware Bodies. A. Heath and A. Leese, 121
Formula : Schöne's — 119
Forsyth, G. M.—Art in the Pottery Industry, 2
— — — Toleration in Art, 16
Franchet, L., 127
Frits : Lead Silicate — often Discoloured when taken from the Kiln. How can this be remedied ? 63
Fuel : When Inferior — is used for Firing Glost Ovens and Enamel Kilns, what precaution should be taken ? 105

G

Gas Firing. E. W. Smith, 20
Gimson, J.—Improvements in Swedish Pottery, 55
Glasenapp, M., 83, 92
Glaze : Why does — containing Tin Oxide produce a Ruckled or Pimpled surface when a Slow-dragging Fire is used ? 68
Glaze : Would — respond to Interior or Exterior of Quick Fired Biscuit Body ? 58
Glost Placing, 45
Gray, A. E.—Improvements in Swedish Potteries, 54
Grimwade, C. D.—Crazing, 59
— — — Effect of Calcination of Flints on Earthenware Bodies, 124
— — — Is the Sounding of a Piece of Pottery a Logical Test of its Degree of Firing ? 111
— — — Spanish and Portuguese Potteries, 82
Grinding, 41

H

Haddon, C. L.—83, 92
Hard-fired Biscuit Earthenware Crazes more readily than Easy-fired, 56
Heath, A.—Crazing, 60, 62
— — Effect of Calcination of Flints on Earthenware Bodies, 124, 126
— — Elutriation Test for Potters, 115
— — Is the Sounding of a Piece of Pottery a Logical Test of its Degree of Firing ? 111
— — Lead Silicate Frits often come from the Kiln Dark and Discoloured, 65
— — Why does a Glaze containing Tin Oxide produce a Ruckled or Pimpled Surface when a Slow-dragging Fire is used ? 69
— — and A. Leese—Effect of Calcination of Flints on Earthenware Bodies, 121
Hind, S. R.—Lead Silicate Frits often come from the Kiln Dark and Discoloured, 64
— — — Spanish and Portuguese Potteries, 82
Hoff, Van't.—83,
Hutcheson, J. S.—Lead Silicate Frits often come from the Kiln Dark and Discoloured. 66

I

Improvements in Swedish Potteries. A. S. W. Odelberg, 47

J

Jones, R. H. H.—Crazing of Hard-fired Biscuit Earthenware, 58
— W. J.—Symposium on Gas-firing, 37

K

Keane, A. L., 83, 92

L

Lead Silicate Frits, 63
Le Chatelier, 83

Leese, A.—Cracking of Cast Pot in the Clay State at the Seams where Joints in the Mould occur, 66
— — Effect of Calcination of Flints on Earthenware Bodies, 120
— — Improvements in Swedish Potteries, 52
— — see A. Heath, 121
Lindley, W.—Crazing, 62, 63
— — Effect of Fine Ground or Overground Flint on Bodies, 67
— — Recent Visit to Spanish and Portuguese Potteries, 72
— — Why does a Glaze containing Tin Oxide produce a Ruckled or Pimpled Surface when a Slow-dragging Fire is used ? 71
Losses : Avoidable — 45
Lovatt, L. D.—Improvement in Swedish Potteries, 52

M

Majolica Tile : What is the cause of Blibbing on the — — 106
Manufacturer's Point of View of Pottery Design. H. J. Plant, 8
Marignac, 83
Marlow, J. H.—Symposium on Gas-firing, 33
Mellor, J. W.—Elutriation Test for Potters, 115
— — — Improvements in Swedish Potteries, 53
— — — Is the Sounding of a Piece of Pottery a Logical Test of its Degree of Firing ? 110, 111
— — — Plea for Toleration in Art, 11
— — — Thorpe's Solubility Ratio, 120
Meredith, J.—Crazing, 62
— Lead Silicate Frits often come from the Kiln Dark and Discoloured, 64
— Why does a Glaze containing Tin Oxide produce a Ruckled or Pimpled Surface when a Slow-dragging Fire is used ? 69
Mill and Slip House, 41
Moore, B.—Blibbing on a Majolica Tile, 107
— — Effect of Calcination of Flints on Earthenware Bodies, 124
— B. J.—Crazing, 58
— — — Crazing of Hard-fired Biscuit Earthenware, 57
— — — Effect of Fine Ground or Overground Flint on Bodies, 67
— — — Is it advisable to use the Same Mixtures for China and Earthenware Saggars ? 68
— — — Lead Silicate Frits often come from the Kiln Dark and Discoloured, 64, 65
Moore, B. J,—Saggars, 93, 98, 104
— — — Why does Glaze containing Tin Oxide produce a Ruckled or Pimpled Surface when a Slow-dragging Fire is used ? 70
Mould Making, 42
Myers, E. M.—Symposium on Gas-firing, 24
— — Improvements in Swedish Potteries, 51
— — Effect of Calcination of Flints on Earthenware Bodies, 124
— — Is the Sounding of a Piece of Pottery a Logical Test of its Degree of Firing 110
— — Saggars, 98, 103, 104
— — Spanish and Portuguese Potteries, 80, 81, 82

O

Odelberg, A. S. W.—Further Recent Improvements in Swedish Potteries, 47
Ostwald, W.—83, 92
Oven : Faugeron Tunnel — 74
Ovens : Bisque — 43

P

Perry.—Blibbing on a Majolica Tile, 106, 108
Placing : Glost — 45
Plant, H. J.—Pottery Design from Manufacturer's Point of View, 8
— — — Toleration in Art, 18
Podmore.—Effect of Calcination of Flints on Earthenware Bodies, 126
Porosity, Strength and Absorbing Power of Certain Calcium Sulphate Cements, A. B. Taylor and E. Irvine, 83
Portuguese Potteries. W. Lindley, 72
Potteries : Improvements in Swedish — A. S. W. Odelberg, 47
— : Recent Visit to some Spanish and Portuguese — W. Lindley, 72
Potters : Elutriation Test for — B. Moore, 112
Pottery Design from Manufacturer's Point of View. H. J. Plant, 8
— Industry : Art in the — — G. M. Forsyth, 2
— : Is the Sounding of a Piece of — a Logical Test of its Degree of Firing 110
Potting : Unsolved Problems in — Presidential Address, 39
Presidential Address.—Unsolved Problems in Potting, 39
Printing Shops, 44
Problems : Unsolved — in Potting, Presidential Address, 39

Proceedings, 1920-21, XXIV.
— of the Refractory Materials Section of The Ceramic Society, 1920-21, XXVI.
Publications Received, 127

Q

Question Box, 56, 105

R

Ramsden, C. E.—Improvements in Swedish Potteries, 53
Ratio : Thorpe's Solubility — J. W. Mellor, 120
Richardson, A. G.—Crazing, 58, 59, 60, 62
— — — Crazing of Hard-fired Biscuit Earthenware, 56
— — — Lead Silicate Frits often come from the Kiln Dark and Discoloured, 64
Richmond.—Symposium on Gas-firing, 30
Rohland, 83
Rubinstein, H., 127

S

Saggar Making, 40
Saggars. B. J. Moore, 93
— : Is it advisable to use the Same Mixture for China and Earthenware — ? 68
Salvétat, A., 84, 92
Schöne's Formula, 119
Scott, A.—Saggars, 101, 102
Searle, A. B.—127
Silicate : Lead — Frits ; Why are they often Dark and Discoloured when taken from the Kiln ? 63
Simpson, T.—Improvements in Swedish Potteries, 51
Singh, D.—Blibbing on a Majolica Tile, 108
— — Spanish and Portuguese Potteries, 80
Slip House, 41
Smith, E. W.—Symposium on Gas-firing, 20, 37
Société de Chimie Industrielle, Paris : Annual Congress and Exhibition of the — — — 127
Solubility Ratio : Thorpe's — — J. W. Mellor, 120
Sounding of a Piece of Pottery : Is it a Logical Test of its Degree of Firing ? 110
Spanish Potteries. W. Lindley, 72
Speirs, C. W.—Symposium on Gas-firing, 36
Steele, H. L.—Saggars, 103
Strength of Calcium Sulphate Cements. A. B. Taylor and E. Irvine, 83
Suction Tests, 85
Swedish Potteries : Recent Improvements in — — A. S. W. Odelberg, 47
Symposium on Art, 1
— — Gas-firing. E. W. Smith, 20

T

Taylor, A. B., 92
— — — and E. Irvine.—Porosity, Strength and Absorbing Power of Calcium Sulphate Cements, 83
Tensile Tests, 87
Test : Elutriation — for Potters. B. Moore, 112
— : Brinell's — 85
Tests : Crushing — 87
— : Suction — 85
— : Tensile — 87
Thomas, C.W.—Symposium on Gas-firing, 34
Thorpe's Solubility Ratio. J. W. Mellor, 120
Tile : What is the Cause of Blibbing on the Majolica — 106
Toleration in Art. J. W. Mellor, 11
Transport : Mechanical — 45
Tunnel Oven : Faugeron — — 74
Turner, F.—Crazing, 61
— — Crazing of Hard-fired Biscuit Earthenware, 56
— — Discoloration of Lead Silicate Frits when taken from the Kiln, 63, 65

U

Unsolved Problems in Potting. Presidential Address, 39

V

Van't Hoff, 83

W

Williams, 83
— G. A., 92
Wilson, S. T.—Symposium on Gas-firing, 27
Wooldridge, F. R.—Spanish and Portuguese Potteries, 80
Wolski, 83, 92
Wood, H. E.—Saggars, 103
Worthington, F. S.—Curling Back and Cracking of the Edges of Flatware, 110
— — — Is the Sounding of a Piece of Pottery a Logical Test of its Degree of Firing ? 111
— — — Spanish and Portuguese Potteries, 79
— — — What Precautions should be taken when Firing Glost Ovens with Inferior Fuel ? 105

THE CERAMIC SOCIETY.

TRANSACTIONS.

LIST OF VOLUMES IN STOCK.

Vol.	I.	—	Out of Print
,,	II.	—	Out of Print
,,	III.	50	
,,	IV.	40	
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,,	XIV.	—	Out of Print
,,	XV.	—	7 only Part II.
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OF

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VOL. XX.—1920-21.

ABSTRACTS.

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Introduction.

THE following are abstracts from papers connected with the clay, refractories, and glass industries in the more important foreign journals as well as those of our own country. The abstracts are arranged roughly in thirteen classes. The groups are constantly overlapping, and, to avoid repetition, a copious index is appended. This will enable any reference to be quickly found. Most of the journals quoted are permanently filed so that the full papers may usually be consulted by members of the Society. Full translations of any of the foreign papers can be obtained at a small charge. As a rule the abstractor indicates the "subject title" of those articles which, in his opinion, contain either no original matter, or matter not suitable for abstraction.

These abstracts were made possible by a grant from the Joint Committee of Allied Pottery Manufacturers, and were compiled by Mr. J. A. AUDLEY, B.Sc. and Mr. F. SALT (with the exception of a few initialled).

The following particulars respecting patents may be of use to members:—

Country	Address	Cost
Britain ..	Patent Office, London	One Shilling (extra postage outside United Kingdom)
United States	Patent Office, Washington ..	Five cents
France ..	L'Imprimerie Nationale, 87, Rue Vielle du Temple, Paris	One franc
Germany ..	Patent Office, Berlin	One mark
Austria ..	Buchhandlung Lehmann und Wenzel, Wien I, Kärntnerstrasse, 30	One krone
Denmark ..	Patent Office, Copenhagen ..	One krone
Norway ..	Patent Office, Christiania ..	One krone
Sweden ..	Patent Office, Stockholm ..	One krone
Italy ..	— — Rome	Specifications not printed
Japan ..	— — Tokyo	Price not stated
Australia ..	Government Printer, Melbourne	One shilling

Of Canadian Patents, manuscript copies only are obtainable. They may be secured from Fetherstonhaugh & Smart, or the Commissioner of Patents, Ottawa. Estimates of cost may be obtained in advance.

In ordering a copy of a patent, the number of the patent and year of the patent, the name of the patentee and the subject of the invention should be stated.

Titles of Journals Abstracted, with Abbreviations.

Amer. Jour. Sci ..... "American Journal of Science" (American)
Amer. Pot. Gaz. ..... "American Pottery Gazette" (American)
Ber. D. K. Ges. "Berichte der Deutschen Keramischen Gesellschaft" (German)
Brick ..... "Brick and Clay Record" (American)
Brick Pot. Tr. J. ..... "Brick and Pottery Trades Journal" (British)
Brit. Claywr. ..... "British Clayworker" (British)
Bull. Imp. Inst. ..... "Bulletin of the Imperial Institute" (British)
Cement Eng. News ..... "Cement and Engineering News" (American)
Cer. ..... "La Céramique" (French)
Cer. Vet. ..... "La Ceramica ed il Vetro" (Italian)
Chem. Appar. ..... "Chemische Apparatur" (German)
Chim. Ind. ..... "Chimie et Industrie" (French)
China Rev. ..... "China and Clay Trade Review" (British)
Claywr. ..... "Clayworker" (American)
Deut. Töp. Zieg. Ztg. .. "Deutsche Töpfer und Ziegler-Zeitung" (German)
Diamant ..... "Diamant Glas-Industrie Zeitung" (German)
Eng. Ind. Man. ..... "Engineering and Industrial Management" (British)
Faenza ..... "Faenza" (Italian)
Feuerung ..... "Feuerungstechnik" (German)
Giorn. Chim. .... "Giornale di Chimica industriale ed applicata" (Italian)
Glas-Ind. ..... "Die Glas-Industrie" (German)
Ind. Chim. ..... "L'Industrie Chimique" (French)
J. Soc. Chem. Ind. .. "Journal of the Society of Chemical Industry" (British)
J. Soc. Glass Tech. .... "Journal of the Society of Glass Technology (British)
Kalk. Schm.-Ztg. ..... "Kalk-, Gips- und Schamotte-Zeitung" (German)
Ker. Rund. ..... "Keramische Rundschau" (German)
Silik. Zeits. ..... "Silikat-Zeitschrift" (German)
Min. Min. ..... "Mines and Minerals" (American)
Monit. Cer. Ver. .. "Moniteur de la Céramique et de la Verrerie" (French)
Pat. J. ..... "The Illustrated Official Journal (Patents) (British)
Porz. Glas. ..... "Die Porzellan and Glashandlung" (German)
Pot. Gaz. ..... "Pottery Gazette" (British)
Pot. Glass ..... "Pottery and Glass" (American)
Pot. Glass Rec. ..... "Pottery and Glass Record" (British)
Prod. Chim. ..... "La Revue des Produits Chimiques" (French)
Quarry ..... "Quarry" (British)
Sprech. ..... "Sprechsaal" (German)
Stahl Eis. ..... "Stahl und Eisen" (German)
Tonind. Ztg. ..... "Tonindustrie-Zeitung" (German)
Tonwaar. Ind. ..... Tonwaaren Industrie" (German)
Tonwar. Ofen. Ztg. ..... "Tonwaren-Ofen und Töpfer Zeitung" (German)
Tonwar. Fab. ..... "Tonwarenfabrikant" (German)
TRANS. ..... "Transactions of the Ceramic Society" (British)
Trans. Amer. Cer. Soc. .. "Transactions of the American Ceramic Society" (American)
Zeits. angew. Chem. ..... "Zeitschrift für angewandte Chemie" (German)
Zentr. Bauk. .. "Zentralblatt für Baukeramik and Glasindustrie" (Austrian)

Also a number of other Journals not devoted exclusively to Pottery and Clays.

There is a difficulty in procuring some Continental Journals; and some ceased publication while the war was on.

*** The first number represents the number of the volume, the last the year of publication, and intermediate numbers the page or pages where the subject is discussed.

Abstracts.

I.—RAW MATERIALS: GENERAL

POTASSIUM SALTS.—Chemical Construction Co. (*Pat. J.*, No. 1621, 1920). Pat. No. 136,718, Feb. 24, 1919. Apparatus for recovering potassium compounds from gases of a cement kiln, in water or other liquid, comprises two sets of towers having a pump between them connected to the top of a tower of one set and to the bottom of a tower of the other set; all the towers are in series with respect to the gases, while each set has a separate liquid circulation (by its own pump). The liquid for the first set of towers is drawn off for filtration in a press, or may be evaporated to dryness without filtration, for use as a fertilizer; but the liquid for the second set is drawn off without filtration, as it contains no insoluble matter.

SUBSTITUTES FOR FOREIGN—PARTICULARLY ENGLISH—RAW MATERIALS IN THE GERMAN CERAMIC INDUSTRY.—J. Klug (*Sprech.*, **53**, 181, 1920). As a substitute for English China Clay and Cornish Stone, Birkenfeld felspar, containing about 37—40% quartz, 34—36% felspar, and 25—27% alumina, is suggested.

SAND FOR SAND LIME BRICKS.—B. Krieger (*Tonind. Ztg.*, **43**, 307—8, 19, 31—2, 46—7, 1919). Sand of uniform grain encloses a larger total volume of hollow spaces than sand of mixed grains. For sand-lime bricks, the quantity of lime required depends upon the number and size of the hollow spaces. The total volume of empty spaces can be determined from the weight per litre by means of the formula: $d = \frac{W}{S}$ when d = degree of density, W = weight of body + empty spaces per unit of volume and S = *sp. gravity* of the material itself (2·6 for quartz sand). The values for 5 sands were the following:

Sand No.	Weight per litre in kg.	Empty Spaces in ccm.
1	1·835	294
2	1·760	323
3	1·672	357
4	1·631	373
5	1·583	391

PROSPECTING FOR CLAY.—L. Schmelzer (*Tonind. Ztg.*, **40**, 457, 1916). For proving beds of clay for brick-making, the writer considers boring to be unsatisfactory, and that the cores do not show the true nature of the beds. A stratum of clay, for example, containing limestone pebbles might, judging from the core, be pronounced to contain only fine particles of lime, owing to the borer having ground up the small pebbles. Small openings are preferable, as they can be examined at any time, and up to 3 m. deep, are not more costly than small bore-holes. P.W.T.

RAW MATERIALS: OCCURRENCE, PREPARATION, ETC.

FILTER SAND.—G. Anklam (*Tonind. Ztg.*, **43**, 655, 1919). A general description of the method of preparation, requisite size of grain, etc.

CLAYS AND SHALES OF MINNESOTA.—F. F. Grout (*U.S. Geol. Survey, Bulletin* 678, 1919). A detailed survey, dealing with the clays of Minnesota by counties. Sections on the geology, physical and chemical properties, and technology of clay are also included.

ALUMINATES.—Rochette Frères (*Pat. J.*, No. 1639, 1920). Pat. No. 141,666, Dec. 3, 1919. Calcium aluminate practically free from other oxides is produced by heating bauxite, or other aluminium ore, with lime and carbon or silicon, aluminium or calcium carbide in an electric furnace, whereby all the foreign oxides are reduced to the metallic state. Acidic

oxides, such as those of silicon and titanium, form ferrous alloys which separate at the bottom of the furnace and are suitable for use in the metallurgy of iron. In place of lime, baryta or other alkaline earth may be used. The alkaline earth aluminates are converted into alkali metal aluminates, such as sodium aluminate, by treating their hot solutions with alkali metal carbonates.

HUNGARIAN BAUXITES.—(*Sprech.*, **52**, 487—8, 1919). A short account of the extensive bauxite deposits of the Bihar mountains taken from a paper by O. Paul—"The aluminium ores of the Bihar Mountains." The following is an analysis of the Hungarian bauxites:

	1	2	3	4	5	6	7	8	9	10
Al_2O_3 ..	53·23	22·96	57·04	5·86	53·46	57·50	72·38	57·78	63·16	62 0[illegible]
Fe_2O_3 ..	12·86	9·99	26·34	20·02	19 46	19·15	14·36	31 82	18·16	20 5[illegible]
H_2O ..	8·87	6·42	11·16	?	?	11·15	10·81	11 21	12 93	16·3[illegible]
SiO_2 ..	13·94	55·26	4·63	16·57	20·51	7·37	2·78	0·64	2·	2·6[illegible]
TiO_2 ..	—	0·45	—	—	—	3·05	—	2 98	3·	trac[illegible]
P_2O_5 ..	1·39	—	—	—	—	trace	—	—	—	0 9[illegible]
CaO ..	trace	0·36	—	0·31	0 39	1·16	—	—	—	0·9[illegible]
Ni + Co ..	,,	—	—	—	—	—	—	—	—	trac[illegible]
Zn ..	,,	—	—	—	—	—	—	—	—	,,
MgO ..	,,	0·36	—	0·13	0·42	—	—	—	—	,,
Cu ..	,,	—	—	—	—	—	—	—	—	,,

Nos. 1 to 6—Bauxites of the Remeczar district, rich in silica.
Nos. 7—10, Kiralyerdö bauxites, poor in silica.

HUNGARIAN BAUXITE.—(*Tonind. Ztg.*, **40**, 739, 1916). Analysis of a bauxite containing much iron, from the Idar Valley. Melts at cone 30.

Loss on ignition	11·16
Silica	4·00
Alumina	52·50
Iron Oxide	32·12
Calcium Oxide	0·12
Magnesium Oxide	0·10
	100·00

P.W.T.

"BUY BURNED LIME ACCORDING TO ITS CALCIUM OXIDE CONTENT."—H. Eckert (*Tonind. Ztg.*, **40**, 108, 1916). Criticism of a German precept regarding manuring with lime. Given proper fuel, burning and examination of the calcined product, it is inexplicable that inferior lime should be produced—as it is sometimes said to be. Lime with a low calcium oxide content can only be due to using inferior strata of limestone with those of the best quality. P.W.T.

ALUMINA.—K. J. P. Orton and G. W. Robinson (*Pat. J.*, No. 1631, 1920). Pat. No. 139,005, Feb. 26, 1919. Materials containing alumina and iron, such as slate, are ground and heated with sulphuric acid or nitre cake and leached, the solution being made up to a dilution such that the weight of the solution is of the order of 150 times the weight of the slate or the like. The solution is then heated to 70—80 C., when part of the iron precipitates as ferric hydrate. The remaining solution is treated for the production of alumina, which may be freed from the remaining iron in known manner.

ALUMINIUM NITRIDE.—V. Gerber (*Pat. J.*, No. 1631, 1920). Pat. No. 139,195, Feb. 18, 1920. Aluminium nitride is obtained by passing

nitrogen into molten alumina in presence of a reducing agent, such as carbon or a reducing gas or vapour while electric energy is supplied to maintain the temperature. Coal dust and a nitrogenous gas, with or without a reducing gas, may be blown into or sucked through molten alumina, or the liquid alumina, in an atmosphere of nitrogen, may be caused to flow across carbon having a large surface, the operation in either case being effected in an open or closed arc or resistance furnace. The alumina may be prepared by melting in an electric furnace a mixture of aluminous material and carbon, or aluminous material, carbon, and iron or ferric oxide.

DRYING CHINA CLAY.—J. Adair (*Pat. J.*, No. 1641, 1920). Pat. No. 142,161, Dec. 16, 1918. Comprises a combination of mechanical loading apparatus, drying floors with heating means, and means connected with the floors for unloading the dried clay from the floors.

PHYSICAL AND CHEMICAL PROPERTIES, TESTING, ETC.

COMPOSITION, DRYING AND FIRING SHRINKAGE, POROSITY, AND DENSITY OF BRITISH FIRECLAYS SUITABLE FOR GLASS FURNACE REFRACTORY MATERIALS.—E. M. Firth, F. W. Hodkin, and W. E. S. Turner (*J. Soc. Glass Tech.*, **4**, 162, 1920). The general aim of the work on which the paper is based includes the investigation of the chemical composition of the raw clays, the shrinkage on drying and firing, the porosity, density, and refractoriness both with and without load. Also the effect of purification of clays on the properties mentioned, the effect on the shrinkage and porosity of mixing various clays, and the influence of the relative proportions and sizes of grog particles. It is further hoped to investigate the corrosive influence of the raw materials and of glass batches on burned prepared fireclays. The present paper deals with one German and 26 British fireclays, the temperatures employed ranging up to 1400°C. With certain modifications (specified) the standard tests described in the *Trans. Cer. Soc.*, **17**, 300, 1918, were used.

The percentage of water required to produce working consistency in the different clays ranged from 18·1 to 29·0, but only 2 had less than 21 per cent., and only 3 had more than 26·6 per cent., so that for 22 of the 27 clays the water only varied between 21 and 26·6 per cent. There is apparently no relation between the amount of water required and the composition of the clay, nor between the size of particle and the amount of water required.

As regards composition of the calcined clays, some had high alumina content, 8 ranging from 35·55 to 41·15 per cent., and one having as much as 52·48 per cent., the rest ranging from 19·02 to 31·67 per cent. The silica content ranged from 49·34 to 57·35 in 8 clays, from 60.46 to 69.61 in 9 clays, and from 71·90 to 75·60 in 9 others; in one case it was as low as 42·36 per cent., with the alumina (52·48) considerably more, this being the remarkable bauxitic fireclay of Ayrshire. No success resulted from an attempt to correlate the calculated mineral composition with certain physical properties (shrinkage). Composition is also discussed with reference to the chemical compositions of clays for tank blocks and for pots as laid down in the Provisional Specification for Glass Works Refractory Materials, issued by the Refractories Research Committee of the Society of Glass Technology. The majority of the British clays fail to reach the standard in their natural state. Thus only 5 of the clays would satisfy the requirements for Grade I. for a bind clay for pot making as regards iron content. In 17 of the clays the Fe_2O_3 exceeds the limit for even Grade III. Of all the clays considered, only 5 British clays would meet the requirements for Grade III., one of them just failing to reach Grade I standard for a base clay. Most of the clays (if not all) would be improved by purification, but strict limits of composition cannot be laid down at present.

The authors suggest, as the simplest plan, the fixing of a maximum content of iron oxide, and then judging the clay further by its physical properties, such as shrinkage and porosity, determined at various temperatures as well as by its working properties. Refractoriness, of course, should be taken into account also. Clays of similar chemical composition though

usually similar in working properties, may have very different shrinkages and porosities.

The shrinkage, porosities, and general characteristics of the individual clays are briefly described, the shrinkage and porosities at different temperatures being represented by plotted curves.

Shrinkage as a rule undergoes but little change until a temperature of at least 750°C. has been attained, that is, until the uncombined water has been removed. In many clays shrinkage is not continuous over the range 0—750° or 0—900°, and there may be even slight expansion instead of contraction. With most of the clays, a sudden expansion occurs, in one at 500°, in another at 600°, and in others at 750°, or 900°C. respectively. These changes are most likely associated with allotropic changes in the free silica (quartz) present, and in the few cases where shrinkage increases regularly the clays are rich in alumina, although all the highly aluminous clays do not show quite regular shrinkage. It is desirable that a clay should possess small initial shrinkage, slow and regularly increasing shrinkage up to 750° or 900°, and as small and as regular a subsequent change in the shrinkage as possible.

The two clays of exceptionally high porosity are both rich in alumina, and those of wide range of porosity also have a high or moderately high alumina content; one very siliceous clay (Grossalmerode) also has a wide range of porosity Clays with a short range of porosity include eight siliceous and four aluminous clays. Clays with a wide range of porosity also generally have a considerable proportion of the fluxes lime, magnesia, potash, and soda.

Clays containing more than 2 per cent. total of the fluxes lime, magnesia, potash, and soda, usually exhibit marked shrinkage when fired above 750°, and have a wide range of porosity. Clays containing less than 2 per cent. total fluxes have a smaller shrinkage and porosity range. Distinct exceptions to both statements occur, but usually shrinkage and porosity change vary with the proportion of fluxes. Thus the range of porosity in a clay could probably be extended by the addition of fluxes (*e.g.*, felspar).

The apparent specific gravities depend on the relative change in the porosity and the specific volume (shrinkage) of the clay.

The actual density of a fired clay depends on a number of factors the effect of which it is not easy to determine.

From the tables of shrinkage, porosity, and apparent specific gravity of the individual clays, it is possible to predict approximately what shrinkage, porosity, and apparent specific gravity a mixture of clays, with or without grog, will have when fired to a definite temperature within the range 110°—1400°C. The authors confirmed this statement by experiments on mixtures of three clays and grog.

LIME AS LUBRICANT.—Anon. (*Tonind. Ztg.*, **43**, 428—9, 1919). The following mixtures have been used in the Patrick-Reisert Tovote lubricants:

Mineral Oil	100	100	100	100
Linseed or Rape Oil.. ..	30	30	25	30
Mineral Wax	20	20	25	30
Lime	9	—	10	15
Dolomite	—	9	—	—

For Belgian wagon lubricant 100 kg. dry slaked lime, 12 litres caustic soda solution, and 300 kg. rosin oil are mixed and stirred until the whole becomes white. The mixture is then gently heated and stirred constantly while 300 kg. tar oil are poured in. Finally, 800 kg. German paraffin and 800 kg. finely ground talc are added, and the mixture is stirred until it reaches the consistency of thin paste.

BAVARIAN TRASS.—Gebauer (*Tonind. Ztg.*, **43**, 347—9, 1919). A comparison of Bavarian with Rhenish trass.

POSSIBILITIES OF POTTERY MANUFACTURE FROM IOWA CLAYS.—W. G. Whitford and O. J. Whittemore (*Iowa State College Off.*

Bul. No. 4, 1920). A paper describing in general terms the properties of various Iowa clays and their suitability for the manufacture of different kinds of ware. The following basic glazes were prepared and used in a series of experiments:—

Chemical Formulae.		*Batch Weight.*		
(**A**) Yellow brown mat, (Fe_2O_3).		Iron Oxide ..	16·0	Gms.
·55 PbO, 25 CaO, ·20K_2O	·35 Al_2O_3, ·10 Fe_2O_3, 1·5 SiO_2	Felspar	111·4	,,
		Whiting	25·0	,,
		White lead ..	141·9	,,
		N.C. Kaolin ..	3·87	,,
			333·0	,,
(*B*) Red mat. ($K_2Cr_2O_7$).		Red base	34·0	Gms.
·70 Pbo, ·20 CaO, ·10 K_2O	·38 Al_2O_3, 13·6 SiO_2, Red base (Drakenfeld) 10%	Felspar	56·0	,,
		Whiting	20·0	,,
		White lead ..	180·0	,,
		Florida clay ..	72·0	,,
		Flint	12·0	,,
			374·0	,,
(*C*) Blue mat. (CoO)		Cobalt oxide ..	2·4	Gms.
·03 CoO, ·52 PbO, ·25 CaO, ·20 K_2O	·35 Al_2O_3, 1.5 SiO_2	White lead ..	134·2	,,
		Whiting	25·0	,,
		Felspar	111·4	,,
		N.C. Kaolin ..	38·7	,,
			311·7	,,
(*D*) Green mat. (CuO).		Copper oxide ..	7·9	Gms.
10 CuO, ·52 PbO, ·25 CaO, ·20 K_2O	·35 Al_2O_3, 1 5 SiO_2	White lead ..	116·1	,,
		Whiting	25·0	,,
		Felspar	111·4	,,
		N.C. Kaolin ..	38·7	,,
			299·1	,,
(*E*) Purple mat. (MnO_2).		Manganese dioxide	6·09	Gms.
·07 MnO_2, ·53 PbO, ·25 CaO, ·20 K_2O	·35 Al_2O_3, 1·5 SiO_2	White lead ..	136·74	,,
		Whiting	25·00	,,
		Felspar	111·40	,,
		N.C. Kaolin ..	38·70	,,
			117·93	,,
(*F*) Yellow mat. (Sb_2O_3).		Yellow base ..	34·0	Gms.
·70 PbO, ·20 CaO, ·10 K_2O	·38 Al_2O_3, 1·36 SiO_2, 10% Yellow Base (Drakenfeld)	White lead ..	180·0	,,
		Whiting	20·0	,,
		Felspar	56·0	,,
		Florida clay ..	72·0	,,
		Flint	12·0	,,
			374·0	,,

Chemical Formulæ.			*Batch Weight.*		
(*G*) Gray Orange mat. (U_2O_3).			Uranium oxide ..	36·2	Gms.
·55 PbO	·35 Al_2O_3	1·5 SiO_2	White lead.. ..	141·9	,,
·25 CaO	·05 U_2O_3		Whiting	25·00	,,
·20 K_2O			Felspar	111·4	,,
			N.C..Kaolin ..	38·7	,,
				343·2	Gms.
(*H*) Light Gray mat. (NiO)			Nickel oxide ..	22·5	,,
·03 NiO	·35 Al_2O_3		White lead ..	14·19	,,
·55 PbO			Whiting	22·00	,,
·22 CaO			Felspar	111·40	,,
·20 K_2O			N.C. Kaolin ..	38·70	,,
				316·25	,,
(*I*) Light Blue mat.			White lead ..	138·00	Gms.
·0060 C_0O	36 Al_2O_3	1·32 SiO_2	Whiting	29·00	,,
.5400 PbO			Felspar	83·00	,,
·2900 CaO			N.C. Kaolin ..	54·00	,,
·1500 K_2O			Cobalt oxide ..	·48	,,
·0025 MnO_2			Copper oxide ..	1·17	,,
·0150 CuO			Manganese dioxide	·29	,,
				305·94	,,

REFRACTORY BOND CLAY.—Prof. Dr. Seger and Cramer (*Tonind. Ztg.*, **40**, 616, 1916). Communication from the Clay Industries Chemical Laboratory. In spite of the numerous published records of the properties of bond clays, it is often difficult to obtain comparative figures showing that a clay has proved to be good in practice. Figures are given of a Bohemian clay, which has been used for many years in the manufacture of refractory goods. This clay is, of course, fat and highly plastic. Residue on a 900-mesh lawn only 0·45% sand and mica, on a 5000-mesh, 1·9%. The fired clay is from yellowish to brown.

	110° C dried.	Fired.
Loss on ignition	12·59%	—
Silica	50·50%	57·78%
Alumina	38·35%	38·39%
Iron Oxide	1·75%	2·00%
Calcium Oxide	0·46%	0·52%
Magnesium Oxide	Trace	Trace
	98·85%	98·63%

Refractoriness Seger Cone, 34

	Total Contraction.	Dried to fired.	Perosity.
Seger Cone 010*a* ..	8·5 ..	1·4 ..	21·7
,, 08*a* ..	8·3 ..	1·2 ..	21·1
,, 05*a* ..	9·1 ..	2·1 ..	18·7
,, 01*a* ..	15·3 ..	8·7 ..	6·8
,, 3*a* ..	16·6 ..	10·0 ..	3·1
,, 6*a* ..	16·2 ..	9·7 ..	4·1
,, 10 ..	16·6 ..	10·0 ..	0·1
,, 12 ..	17·5 ..	11·0 ..	0·1
,, 14 ..	16·2 ..	9·7 ..	0·0
,, 17 ..	15·7 ..	7·0 ..	0·0

Above cone 12, the clay has a tendency to expand, which may be regarded as a very favourable property.

P.W.T.

II—MANUFACTURING PROCESSES: GENERAL.

UNBURNED BRICKS.—Hirsch (*Tonind. Ztg.*, **43**, 332—3, 1919). An article discussing possible means of producing satisfactory raw bricks for building purposes, in view of the Government instructions prohibiting the use of coal in the brick industry.

METAL COATINGS.—H. Welte (*Tonind. Ztg.*, **40**, 646, 1916). German Patent 288435. A thin layer of powdered metal is sprinkled or sieved on (or under, in some cases) the body and then pressed under high pressure. The metal coating can be polished, etched, or receive another coating of metal. Some details are given of the process of covering sand-lime bricks and asbestos cement tiles. Pipes may be so treated and can be soldered; also sinks, baths, acid-proof articles, etc. The body to be coated needs no special preparation. P.W.T.

UTILIZING SLAG.—T. F. Hoare (*Pat. J.*, No. 1636, 1920). Pat. No. 140,874, Feb. 12, 1919. Relates to the utilization of blast-furnace slag in the production of bricks, blocks, tiles, slabs, door and window frames, baths, sinks, pipes, conduits, and other parts of workmen's dwellings, garages, bungalows, outbuildings, etc. Also electric insulators, electric main conduits, the bed-plates of electric generators, kerbing, tanks, etc. The slag is broken up, graded, and filled into moulds, which are then filled with molten slag so as to bind the particles of graded slag together. The graded slag may be heated, and the molten slag may be mixed with 10 to 15 per cent. of silica, lime, or other binding agent, and also metallic oxides for colouring purposes; or the metallic oxides may be applied to the inner faces of the moulds. The moulds may also be heated and gradually cooled for the purpose of annealing the product. Other modified processes are mentioned.

ELECTRIC INSULATORS.—General Electric Co. (*Pat. J.*, No. 1641, 1920). Pat. No. 142,295, April 30, 1919. Electric insulators, particularly those of the type used as bushings, are provided with conducting bodies placed adjacent to the surface of the insulating material, and disposed so as to secure a substantially uniform distribution of potential over the surface of the insulator. An oil-filled insulating-bushing for a central conductor comprises upper and lower insulating portions, the upper part only having one or more conducting-rings shaped so as not to coincide with the equipotential surfaces. By suitably shaping and disposing the rings, any desired distribution of potential may be obtained.

ELECTRIC INSULATORS.—F. Jaentsch (*Pat. J.*, No. 1629, 1920). Pat. No. 138,589, Aug. 15, 1919. The metal parts such as the cap and bolt of a high-voltage insulator have grooves to receive spring rings which also enter grooves in the porcelain body in such a manner that the parts can only be detached by breaking the porcelain. Divided porcelain bodies can be similarly connected.

FIBRO-CEMENT PRODUCTS.—R. V. Mattison (*Pat. J.*, No. 1631, 1920). Pat. Nos. 138,921, **3**, Feb. 12, 1920. The first comprises a continuous process for the manufacture of fibro-cement products, *e.g.*, roofing tiles, wherein fibre (asbestos waste), cement, and water are combined and thoroughly mixed to produce a homogeneous mass which is fed to an extrusion machine, the extruded mass being severed into lengths, treated for the removal of water, and allowed to set. The second relates to a machine for rolling extruded severed sheets of fibro-cement composition, and comprises means for rolling the sheet material in one direction, a second means for rolling it in a direction at right angles thereto, with means for transferring the sheets from one rolling means to the other. In the third apparatus for applying dry colour to asbestos cement sheets, tiles, or shingles comprises

a carrier which conducts the sheets, etc., under brushes rotating in opposite directions, dry colour being applied to one of the bushes by means of a rotating grooved cylinder which constitutes the bottom of a colour container.

ELECTRIC INSULATORS.—V. Tedeschi (*Pat. J.*, No. 1631, 1920). Pat. No. 139,148, Sept. 30, 1919. Addition to 136,142.

ELECTRIC INSULATORS.—H. Lutz (*Pat. J.*, No. 1628, 1920). Pat. No. 138,257, June 11, 1919. Two reversed metal cups are screwed on to an insulating spindle so that one cup enters the other (open end first). For high tensions the spindle may have an insulating sleeve, the space between the spindle and sleeve being packed, or filled with insulating material.

ELECTRIC INSULATORS.—H. Lutz (*Pat. J.*, No. 1629, 1920). Pat. No. 138,539, June 11, 1919. Relates to insulators composed of a body part of good insulation adapted to withstand atmospheric influences, and an insulating core to resist tensile strains, and consists in securing the core to its metal caps by providing the core with flattened ends which are inverted into recesses in the caps and then rotated.

CLAY COOKING UTENSILS.—K. Ernst (*Tonind. Ztg.*, **43**, 141, 1919). See TRANS., **18**, Abs. 121, 1919.

HOLLOW BRICKS, THE BUILDING MATERIAL OF THE FUTURE. L. Schmelzer (*Tonind. Ztg.*, **43**, 636, 1919). The writer summarizes the well-known advantages of the hollow brick over the full brick for ordinary building purposes, and advocates the use of single rather than double sized bricks with longitudinal cavities.

ECONOMIC BUILDING METHODS.—(*Tonind. Ztg.*, **43**, 228—9, 1919). The use of perforated bricks for ordinary building purposes would lead to economies in raw material, quicker and better drying, smaller consumption of fuel, and lower cost of transport. Perforated bricks also possess good insulating properties. The article also describes a method of laying a durable 32 or 38 cm. wall by using face bricks.

COAL SAVING BRICK PRODUCTION.—G. Heyer (*Tonind. Ztg.*, **43**, 369—71, 1919). The coal-shortage problem discussed from the brick-maker's point of view. The advantages claimed for bricks with one, two, three or more holes or hollows are: reduced coal consumption in the manufacture and transport of the bricks; greater insulating power of the walls due to the enclosed stationary air columns, with consequent economy in coal for heating purposes.

NEW BRICK SHAPES AND BUILDING PROCESSES.—Schoenfelder (*Tonind. Ztg.*, **43**, 249—50, 1919). The writer advocates the use of angular bricks, four of which enclose a hollow space, so that the wall really consists of a number of square, hollow columns adjoining each other. The bricks can be made as quickly and easily, and with the same apparatus, as ordinary bricks, and will effect considerable saving in raw material.

FLAT ROOFING TILES?.—(*Tonind. Ztg.*, **43**, 20, 1919). The water condensing on the inner surface of a grooved tile passes through slits on to the outer surface of the tile below it. This is not possible if the tiles are perfectly smooth and are made to fit closely one upon the other, and the result is premature rotting of the laths.

PORCELAIN COINS MADE AT MEISSEN.—Anon. (*Sprech.*, **53**, 354, 1920). The coins are made of a stoneware body, which fires a reddish brown colour. Their uniform hard texture should guarantee satisfactory resistance to ordinary wear and tear. The coins have a nominal value ranging from 10 pfennigs to 5 marks. According to latest information published in the daily press, the Free State of Saxony intends to issue ceramic coins up to a nominal value of 20 marks. On the other hand, the German Imperial (Reich) Authorities definitely decline to relieve the present shortage of small change by bringing this type of coin into circulation.

MANUFACTURE OF TILES FROM CLAYS CONTAINING LIME.—H. Jordt (*Tonind. Ztg.*, **43**, 627, 1919). North German clays, containing considerable quantities of lime, partly in finely divided form but often in pieces ranging to walnut size, present a difficult and troublesome problem when used as raw material for tiles. The writer, who characterizes his proposals as "somewhat revolutionary," suggests that the clay should be first dried and ground. About 10% brick-grog should then be added, and the mixture, which is practically dry (5% water), be dry-pressed in hydraulic presses and fired in tunnel kilns.

COMPOUNDING AND PREPARATION OF BODIES, ETC.

BODIES FOR PORCELAIN BUTTONS.—(*Sprech.*, **53**, 305, 1920). For cone 10, the following body is used: Norwegian spar 100 parts, Zettlitz kaolin 20, borax 3. A body containing 30 parts kaolin, 20 quartz and 50 Norwegian spar may be fired at cone 6, and one consisting of 39 parts kaolin, 30 Norwegian spar, 29 quartz and 2 lime is suitable for firing at cone 7.

PORCELAIN FOR ARTIFICIAL TEETH.—Anon. (*Sprech.*, **53**, 383, 1920). Taken from a paper by A. S. Watts, appearing in *Trans. Amer. Cer. Soc.*, **17**, 190, 1915.

PREPARATION OF SAGGAR CLAY.—(*Sprech.*, **53**, 101, 1920). A hard saggar clay was found to contain lumps of varying size after passing through the pug-mill. To avoid this trouble it is recommended to dry the clay, grind and screen it, and add grog while in a dry condition. Water must then be added, and the body passed through the pug-mill.

FANCY-WARE BODIES AND GLAZES.—Anon. (*Sprech.*, **53**, 234, 1920). A suitable body, fired at cone 12, consists of: clay 40 parts, Swedish felspar 35 parts, and quartz 25 parts; or Zettlitz kaolin 38·54, Tirschenreuth pegmatite 41·67, Swedish spar 19·79. (Tirschenreuth pegmatite contains: 60 parts quartz, 3·5 parts alumina, 36·5 spar.) This body is ground 24 hours at 23 revolutions per minute. A suitable glaze would follow the formula:

$$\left.\begin{array}{l} 0{\cdot}2\ K_2O \\ 0{\cdot}2\ MgO \\ 0{\cdot}6\ CaO \end{array}\right\}\ 0{\cdot}7\ Al_2O_3,\quad 6\ SiO_2$$

made up of 21·10 parts Swedish spar, 6·98 dolomite, 7·59 calcite, 21·06 Zettlitz kaolin (fired to cone 12), and 43·27 quartz. It must be ground for 60 hours at 23 revol. per minute. Body and glaze must be passed over an electro magnet.

FORGOTTEN FLUXES.—G. Balltern.—(*Tonind. Ztg.*, **40**, 646, 1916). Four recipes are given for stoneware body containing Barytes. Barium sulphate and fluorspar have fallen into disuse in Germany. Large quantities of barytes were exported to English potters before the war. P.W.T.

ACID-PROOF STONEWARE.—E. Wille (*Tonind. Ztg.*, **40**, 704, 1916). The chemical composition of 8 stoneware bodies is given, the writer stating that nowhere in technical literature is information to be found as to how the larger or smaller content of the various oxides influences resistance to acids. Nowhere is it stated whether an increase in the silicon dioxide content lessens or increases resistance. The same may be said as regards aluminium oxide. Calcium oxide, magnesium, alkalies are generally considered to decrease resistance; but this point still remains undetermined. It is known that the resistance of glass to acids becomes greater with an increased calcium oxide content. P.W.T.

ARTIFICIAL STONE.—White Heat Products Co. (*Pat. J.*, No. 1621, 1920). Pat. No. 136,580, March 18, 1918. Artificial stone is prepared by mixing with glass a crystalline mineral body which has been subjected to a temperature exceeding 1500°F. and forming, pressing, and heating the mixture to fusion of the glass binder. The mineral body may be a natural substance such as silica, corundum, or a mixture of bauxite and rutile, or an artificial substance such as carborundum or alundum, and temporary binders such as silicate of soda, molasses and stale beer may be used.

BRICKS.—C. C. Millard, R. A. Robertson, and C. J. Cooper (*Pat. J.*, No. 1621, 1920). Pat. No. 136,742, March 28, 1919. A composition for the manufacture of building-blocks and the like consists of 4 parts clinker and/or furnace ashes, of which 1 part or less may be replaced by brick rubble, 1 part of burnt yellow clay, 1 part of Portland Cement, all by volume, and 15 per cent. (of the 6 parts) of a paste consisting of 1 volume of lime to 3 of water. The clinker, ashes, and clay are finely ground and mixed with the Portland Cement, after which the lime paste is added, and sufficient water to render the composition moist, but not soft nor slimy. The blocks are moulded and air-dried.

PORCELAIN COMPOSITIONS.—General Electric Co., (*Pat. J.* No. 1632, 1920). Pat. No. 139,315, March 13, 1919. Oxides of rare-earth metals are used in place of some or all of the free silica in the manufacture of porcelain. Suitable oxides are those of zirconium and titanium. Zircite cement, a compound containing about 81 per cent. zirconia, 14 per cent. silica, and small quantities of other oxides, may also be employed. A typical example contains 35 per cent. felspar, 45 per cent. clay and 15 per cent. zirconia.

HEAT-INSULATING MATERIALS.—International Isolations Co., Christiania (*Pat. J.*, No. 1632, 1920). Pat. No. 139,318, March 15, 1919. Dried and finely ground "moler" (diatomaceous earth) is mixed with a granulous or gritty organic substance, such as cork, peat, and sawdust, which has been previously heated to a temperature of at least 100°C. Water is slowly added to the mixture until a suitable consistency is attained. The product is then moulded, slowly heated to a temperature of 250°C., and finally heated to a temperature of about 1000°C., in order to burn out the organic matter. The product is used for heat-insulation.

REFRACTORY AND ABRASIVE COMPOSITIONS.—E. Assie (*Pat. J.*, No. 1638, 1920). Pat. No. 141,351, April 6, 1920. A refractory and abrasive product is made by heating bauxite with sufficient carbon to reduce all oxides other than alumina, and a proportion of chromium oxide. The mixture on fusion gives a slag chiefly consisting of alumina crystals joined together by a chromium oxide cement, and an iron alloy separable by hand or magnetically. The quantity of chromium oxide should be sufficient to enable the whole of the iron oxide to be reduced, but not so much as to produce a non-metallic alloy.

TREATING SLAG.—A Norwegian Firm (Christiania) (*Pat. J.*, No. 1621, 1920). Pat. No. 136,818, Dec. 15, 1919. Water, with or without steam or other gases, is poured or forced into or upon molten slag so as to form a foam sufficiently liquid to be poured into moulds in which it is cooled so as to form porous bricks or insulating material. The product may be crushed and used as a filling for walls and the like. The supply of water is regulated so that the temperature of the foam will be about 1000°C. At this temperature it is liquid and may be led through an overflow into moulds.

ELECTRIC INSULATION; PLASTIC COMPOSITIONS.—E. F. A. Bultemann (*Pat. J.*, No. 1624, 1920). Pat. No. 137,326, Jan. 2, 1920. An electric insulating material is made from hydraulically stiffening bodies such as cement, gypsum, compounds of magnesium, etc., with an addition of fibrous material such as cellulose, asbestos, peat, slag-wool, glass-wool, viscose, etc., which are intimately mixed with fusible materials such as resins, pitches, hydrocarbous, bitumens, asphalts, sulphur, etc., and then treated with water, pressed, dried, and heated.

MODELLING COMPOSITIONS.—E. J. Buckley (*Pat. J.*, No. 1629, 1920). Pat. No. 138,477, March 24, 1919. Finely ground unburned argillaceous matter is mixed with petroleum jelly or similar hydrocarbon in about the proportion of 10 to 4 for the manufacture of a permanently plastic body which may be made hard by firing. The product is particularly designed for modelling purposes. The following materials may, for example,

be used as the base of the composition; (1) china or ball clay capable of sintering under heat, (2) a mixture of ball clay, china clay, flint, and stone, (3) a mixture of china clay, stone felspar, and bone, (4) parian composed of felspar and china clay, and (5) a mixture of red clay and ball clay. A glaze and flux may be added.

SHAPING, MOULDING, DRYING, ETC.

CASTING SLAG.—T. F. Hoare (*Pat. J.*, No. 1638, 1920). Pat. No. 141,390, Feb. 1, 1919. Slag is cast in moulds having double walls insulated by a filling of asbestos, etc., to ensure even cooling or annealing. The moulds may be made of iron, slag, brass, gun metal, etc., and may be heated prior to casting, *e.g.*, in the annealing chamber or by a small furnace. The invention is applicable to the manufacture of moulded products such as paving, kerbing, flooring, and like blocks, roofing tiles, door and window frames, skirtings, picture rails, acid-resisting tanks, baths, sinks, etc.

FAULTY CASTING OF PORCELAIN.—O. Rose (*Sprech.*, **53**, 155, 1920). The writer thinks that much faulty casting is due to careless workmanship in preparing the plaster, making the moulds, and casting the slip, owing to the fact that the men are paid piece-work instead of day rates. The moulds are not of uniform thickness; in tea-pots, for instance, it is often found that the sides are thicker than the front and back parts, owing to varying thickness in the plaster of the moulds.

KILNS, OVENS, MUFFLES; FIRING TECHNIQUE, ETC.

ELECTRIC GLASS-MELTING FURNACES.—O. Maetz (*Sprech.*, **53**, 420, 1920). The writer first describes the ordinary Rennerfelt steel furnace on the electric arc principle. The great disadvantage of this type for glass melting lies in the fact that particles of carbon become detached from the electrodes and fall into the glass, rendering fining difficult. The reducing action of the carbon on the oxides in the batch also has a bad effect. To overcome these difficulties, the Swedish firm A. B. Elektriska Ugnar, Stockholm, constructed a furnace in which the electric arcs do not burn immediately over the pots. The electrodes are placed vertically over a conductor, on both sides of which are the melting chambers. Another type consists of a circular furnace, in which the electrodes are fitted on to the periphery, leaving the centre free for the pots or tanks. The article is well illustrated.

FIRING KILNS WITH WOOD FROM TREE-STUMPS.—Anon. (*Sprech.*, **53**, 252, 1920). The advantages of the hard wood obtained from the stumps of trees felled in previous years are pointed out, in view of the shortage of coal and ordinary wood fuel. Stumps uprooted by hand give a good fuel, which, owing to its high resinous nature, is at least equal to high-grade brown coal briquets.

FIRING WITH POWDERED FUEL.—(*Sprech.*, **53**, 299, 1920). A general discussion of the advantages and disadvantages of the process. The advantages of powdered fuel are well known. The writer mentions a grinding machine manufactured by the Powdered Fuel Plant Co., of London. One drawback to the introduction of the system lies in the fact that moist, low-grade fuels must be dried before grinding. The above mentioned machine, however, works quite satisfactorily with fuel containing up to 6% moisture, and any heat consumed in preparing fuels for grinding is recovered in the higher calorific value of the powdered material.

REGULATING AIR SUPPLY AND DRAUGHT OF FURNACES.—G. H. Gibson (*Pat. J.*, No. 1621, 1920). Pat. No. 136,774, June 23, 1919. The ratio of primary air to secondary air is regulated by apparatus responsive to the flow or pressure, or both, of the air supplies themselves, and, where mechanical stoking is employed, the total air supply is in proportion to the fuel supply.

COKE OVENS, ETC.—W. E. Davies (*Pat. J.*, No. 1622, 1920). Pat. No. 136,880, Dec. 19, 1918. Consists mainly of improvements in the heating walls of coke ovens and the like for carbonizing or distilling solid materials

such as coal, shale, peat, wood, lignite, cannel, or refuse and either intermittent or continuous in action and covers also processes carried out in the improved oven. The heating wall comprises alternate combustion flues and waste heat flues, behind which is a second set of waste heat flues, the arrangement being such that hot gases from the top of each combustion flue are divided between two waste heat flues in proportions determined by an adjustable valve and by the draught in the respective flues.

GAS RETORTS.—A. E. Whitcher, H. K. Hiller, and Hewitt Construction Syndicate (*Pat. J.*, No. 1622, 1920). Pat. No. 136,910, Dec. 24, 1918. Steam is introduced into a coal gas retort, for the purpose of making water gas, by a distributing block fitted at the back of the retort and supplied with steam through a superheater pipe, which is situated in a waste-gas flue and is led through the stop end of the retort to the block. The block is provided with a steam inlet, an expansion and heating chamber, and distributing passages.

ELECTRODE FURNACES.—T. H. Watson & Co., H. A. Greaves, H. Etchells, and W. Travis (*Pat. J.*, No. 1622, 1920). Pat. No. 136,960, Feb. 21, 1919. A conductive "acid" hearth or lining consists of a layer of broken chromite in contact with metallic connections, and an inner facing of a mixture of silicious material, such as crushed silica bricks, and tar or pitch, with or without finely divided metal. The facing is sufficiently thick to keep the molten metallic charge out of contact with the chromite.

COKE OVENS.—Fours & Procédés Mathy, Soc. Anon. (*Pat. J.*, No. 1622, 1920). Pat. No. 137,005, June 4, 1919. The combustion flues of a coke oven are packed with porous refractory material, amongst which a mixture of gas and air is burned. Two superheated conduits are arranged beneath the sole of each half of an oven, and communicate with the combustion flues on both sides through apertures. Gas and air are supplied to the conduits from mains, the air being heated in its passage through a recuperator. Combustion is effected in the refractory filling of the flues, and the products are exhausted through down flues and the waste gas passages of the recuperator.

DISTILLING; COKING.—M. J. Berg (*Pat. J.*, No. 1623, 1920). Pat. No. 137,045, Dec. 22, 1919. Wood, coal, hydrocarbons, and other substances are distilled, dissociated, refined, coked, or carbonized by mixing them, prior to distillation, with another substance which evolves vapours at a lower temperature.

LINING RETORTS AND FURNACES.—S. A. McMinn (*Pat. J.*, No. 1624, 1920). Pat. No. 137,419, Feb. 28, 1919. A mixture containing 30 per cent. or more of powdered glass together with fireclay, such as Stourbridge or China clay, or a clay containing over 90 per cent. of silica is used as a glazing cement for lining retorts or furnaces. A mixture of china clay with silica clay and ground glass in equal proportions may be employed.

ELECTRODE FURNACES.—Booth Electric Furnace Co., and J. R. Hall (*Pat. J.*, No. 1625, 1920. Pat. No. 137,540, Jan. 8, 1920. A door carries an adjustable electrode which may be used in substitution for a hearth or wall electrode when the furnace is cold. When the hearth becomes conductive, the door and electrode may be swung out of the way and replaced by a main door.

FURNACES, ETC.—D. W. Anderson and A. D. Dabney (*Pat. J.*, No. 1625, 1920). Pat. No. 137,565, Dec. 30, 1918. Relates to an apparatus for automatically regulating the air supply to the fire of a furnace, stove, or other heater.

LOW TEMPERATURE COKING.—J. Swinburne (*Pat. J.*, No. 1625, 1920). Pat. No. 137,572, Jan. 4, 1919. In the low temperature distillation of coal with electric heating, the resistances are arranged within and subdivide a stationary charge. The retorts used may contain 100 tons of coal,

and the process may extend over one or two days. The temperature does not exceed 350°C.

ELECTRODE FURNACES.—A Norwegian Firm (Christiania) (*Pat. J.*, No. 1626, 1920). Pat. No. 137,811, Sept. 8, 1919. An electrode is made by tamping raw carbonaceous material into a metal casing and heating first to a comparatively low temperature, preferably in the furnace in which the electrode is to be used, a part of the heat being produced by current entering the mass through the casing. The electrode may be baked at about 600°C. before use in the furnace, to harden the carbonaceous matter sufficiently to withstand expansion stresses. When employed directly in the furnace, the casing is preferably kept comparatively cool until the mass is baked. Fresh lengths of casing can be attached as required and filled with the mass. At starting, some coke may be placed in the furnace to connect the electrode casing to a bottom electrode. When the furnace is hot and the end of the electrode is baked, the coke is withdrawn. Specifications 116,853 and 119,018 are referred to.

COKE OVENS.—American Coke & Chemical Co. and A. Roberts (*Pat. J.*, No. 1628, 1920). Pats. Nos. 138,124 to 138,128, Jan. 24, 1920. Relate to regenerative ovens, heating-walls, etc.

COKE OVENS.—American Coke & Chemical Co. and A. Roberts (*Pat. J.*, No. 1628, 1920). Pats. Nos. 138,333 to 138,335, Jan. 24, 1920. Relate to coke-oven heating-walls.

ELECTRODE FURNACES.—A Norwegian Firm (Christiania) *Pat. J.*, No. 1628, 1920). Pat. No. 138,354, Jan. 28, 1920. An electrode which is baked in the furnace in which it is used is suspended by a holder attached to its lower hardened portion. The holder may be water-cooled, and may be external or internal.

ZINC OXIDE; RETORT FURNACES.—New Jersey Zinc Co., F. G. Breyer, and E. H. Bunce (*Pat. J.*, No. 1631, 1920). Pat. No. 138,924, Feb. 12, 1920. Zinc oxide is subjected to a temperature between a red and yellow heat for a short time while falling freely in a thin stream through a vertical or inclined retort of elongated section, after which it may be received in a receptacle in which it is kept without substantial loss of temperature for any desired time to improve further its appearance, or may be allowed to cool normally.

ELECTRODE FURNACES (FOR ZINC).—A Norwegian Firm (Askin) (*Pat.J.*, No. 1631, 1920). Pat. No. 139,160, Feb. 3, 1920. A furnace for the extraction of zinc comprises a chamber heated by means of carbon electrodes and surmounted by a pre-heating chamber heated by combustion of gas, such as carbon monoxide from the zinc condensers. Above the pre-heating chamber, there may be a drying chamber.

TUNNEL KILNS.—A. C. Ionides (*Pat. J.*, 1632, 1920). Pat. No. 139,267, Jan. 31, 1919. Tunnel kilns for bricks, pottery, etc. The accommodation in pre-heating, firing, and cooling stages is proportioned to the times required for the respective operations, so that while efficient transfer of heat from one stage to another is maintained, no stage is kept waiting, more or less empty, for goods coming from another. The firing-section constitutes a continuation of the pre-heating section, and communicates also with one or more cooling sections extending adjacent to the pre-heating section and under the same roof, so that heat is directly transferred to the incoming goods by radiation and connection through extended openings. With this arrangement, in order to suit, say, a higher firing temperature, cooling accommodation is readily increased by the use of additional parallel tracks for outgoing goods, and further alteration in relative accommodation in the three stages may be obtained by duplicating the pre-heating and cooling tunnel at the other end of the firing chamber. Drying accommodation may be provided by a second parallel tunnel supplied with hot air from a gas-fired

device, such air, if desired, first absorbing waste heat from, say, the hollow-jacket of the firing section of the main tunnel.

DRESSLER TUNNEL KILN.—J. E. Sproat and D. Allbright (*J. Amer. Cer. Soc.*, **3**, 460, 1920). Relates to data on the operation of the Dressler tunnel kiln in the manufacture of semi-porcelain dinner ware, at Sebring, Ohio.

Perhaps the principal factor in the successful operation of the Dressler tunnel kiln is the quality of the gas and its proper control. Cool gas (straw colour to blue) is desirable, being more free from soot, and if the desired quality of gas is not available, the burners should be cleaned frequently. Brown or black gas may arise from too hot a fuel bed or from blow-holes. Other subjects discussed include standard conditions of operation, the kiln, balanced gas and air supply, factors affecting the quality of the ware, structural features, cost of operation, etc.

It is positively concluded that a greater uniformity of product at a far less cost can be produced in the Dressler tunnel kiln than is possible in any type of periodic kiln in use to-day in the manufacture of semi-porcelain.

COMPOSITION OF KILN GASES AND THEIR EFFECT ON TERRA COTTA GLAZES AND COLOURS.—F. B. Ortman (*J. Amer. Cer. Soc.*, **3**, 476, 1920). A discussion mainly concerning sulphuring, and especially the occurrence and effects of SO_3 gas, and its effects under different circumstances. The conclusions were reached that: (1) there exists within the kiln chamber in contact with the ware, an appreciable amount of SO_3 gas practically from start to finish of the firing; (2) the source of this is a leakage of combustion gases through the muffle wall, until about red heat, when the sulphur begins to distil from the pyrites in the clay; (3) owing to excessive ventilation prevailing at the beginning of the firing, the SO_3 is removed rapidly and does little damage; (4) after the glaze has fused it is not easily susceptible to chemical action of SO_3 upon its surface; (5) the danger zone therefore lies between red heat and the time of fusion of the glaze, and is particularly troublesome because the sulphur being distilled as SO_2 from the pyrites in the clay encounters a moist atmosphere due to the dehydration of the clay forming H_2SO_4, and at a time when the ventilation is apt to be sharply reduced by the closing of trial holes and crown openings; (6) the sulphuric acid thus formed may be taken up by the glaze physically or chemically, resulting in blisters, scum, etc.; (7) the chances of trouble in this period may be very much lessened by maximum ventilation, by adequate secondary air supply in the fire boxes; and by adequate draught and oxidizing conditions throughout. [These points, with some others referred to in the paper, are probably of importance also for other ceramic materials besides terra cotta].

COKING, ETC.—J. E. Christopher (*Pat. J.*, No. 1641, 1920). Pat. No. 142,163, Dec. 30, 1918. A retort for the distillation of coal, oil, shales, etc., is formed with a main external heating flue from which the gases, controlled by dampers, pass to one of two auxiliary series of flues or regenerative sections, further heating the retort. These regenerative sections may be filled with heat-retaining material, such as bricks, and steam may be passed through each of them, alternately with the waste gases from ports. After super-heating, the steam passes through a port controlled by a damper, to a vertical passage leading to a chamber, from which it enters the retort through special passages.

BRICK KILNS.—A. Sharratt (*Pat. J.*, No. 1641, 1920). Pat. No. 142,237, March 4, 1919. The heating gases are filtered through coke, which is afterwards burned. In a continuous kiln, the coke is packed into chambers formed in front of the openings in the partition walls between the kiln chambers. A paper seal is placed over the coke and when this is broken at the required stage of operation, communication between the adjacent chambers is established through the body of coke in its special chambers. As the fire travels through the kiln, the coke is ignited and is allowed to burn

down, so that excess air passes on and prevents overheating of the bricks until they are thoroughly dried. When the drying has been effected the fire is built up by coke fed from the floor above in the usual manner. Secondary air may be supplied through apertures above the fires.

ELECTRODE FURNACES.—Armour Fertilizer Works (*Pat. J.*, No. 1641, 1920). Pat. No. 142,283, April 22, 1919. In a polyphase furnace for chemical reactions such as the production of aluminium nitride, the material passes through a stationary conductive tubular body within which are other stationary electrodes arranged so as to cause substantially uniform heating.

TUNNEL KILNS.—F. Fidler and J. G. Maxwell (*Pat. J.*, No. 1637, 1920). Pats. Nos. 141,124—5, Jan. 6, 1919. The cooling zone of a tunnel kiln fired by coal, gas, or oil, is lined with heat-absorbing bodies, such as cast iron plates, forming flues through which air is passed so that the cooling air does not come into contact with the goods being cooled. The heated air is used for combustion, or in drying tunnels, floors, or closets, or for other purposes.

ELECTRODE FURNACES.—M. L. Boillot and J. Dandignac (*Pat. J.*, No. 1638, 1920). Pat. No. 141,142, Jan. 15, 1919. A furnace of known type, for the manufacture of hydraulic lime and slow or quick-setting cements by fusion of the ingredients, is provided with electrodes which dip into a crucible and are adjusted by winches. Above the crucible is a cylindro-conical shaft into which the materials are fed from a pre-heater above. The hearth of the crucible is made of rammed conducting material, such as earth, resting on a conducting plate connected with a conductor bar.

ELECTRODE FURNACES.—E. Assie (*Pat. J.*, No. 1638, 1920). Pat. No. 141,352, April 6, 1920. Electrode furnaces are designed so that refractory or abrasive substances such as artificial corundum can be obtained in masses of predetermined weight and with slow cooling.

GAS MANUFACTURE.—C. E. Holt and T. Walker (*Pat. J.*, 1640, 1920). Pat. No. 141, 828, Feb. 4, 1919. In generating gas by showering powdered carbonaceous material in the presence of low pressure steam, the coal, etc., is fed to the retort through a steam-jacketed hopper fitted with baffles and a toothed wheel in gear with the exhauster. The steam is supplied through a number of pipes, and the gas may be enriched by injecting oil through pipes.

GAS MANUFACTURE.—R. & J. Dempster, G. F. H. Beard, and G. W. Tooley (*Pat. J.*, No. 1640, 1920). Pat. No. 142,026, Oct. 3, 1919. A hydraulic main is divided into sections, so that a separate seal for each tier of retorts, as described in Specification 25783/05, may be obtained with ascension pipe connections of uniform length. The dip-pipes, and the liquor inlets and outlets, are arranged in line, or approximately so, as described in Specification 2861/04.

ELECTRODE FURNACES.—Scovill Manufacturing Co. and M. H. Bennett (*Pat. J.*, No. 1636, 1920). No. 140,789, March 24, 1920. An automatic controller maintains constant both the power supplied to a furnace and the proportion of this power delivered by each of a number of electrodes. Each electrode may be regulated in accordance both with its potential and with the power delivered by it. Each electrode of a 3-phase furnace is adjusted by a reversible motor, to the armature of which current can be directed through either of two oppositely wound field coils by a switch lever and fixed contacts from direct-current mains. Each arm of the switch lever carries a coil moving between two fixed coils.

ELECTRODE FURNACES.—G. Marsh (*Pat. J.*, No. 1636, 1920). Pat. No. 1440,835, July 4, 1918. Tools, crucibles, metals, or refractory materials are heated by metal molten by an arc, and also by passage of current between a conductor connected with the tools, etc., and a conductor extending into

the molten metal. The tools, etc., may be placed in a pocket in the wall of a furnace containing molten metal, or in a crucible immersed in the metal which is heated by an arc between electrodes, additional electrodes being provided for passage of current through the tools, etc. The metal may consist of a ferrous alloy with chromium, cobalt, and tungsten, and a small percentage of vanadium and molybdenum. An insulated conductor extends between the electrodes.

RETORTS.—J. E. Kennedy (*Pat. J.*, No. 1637, 1920). Pat. No. 141,025, Feb. 20, 1920. A retort for the distillation of oil-shales, coal, and like materials, comprising a horizontally rotatable tapering shell with end trunnion members mounted in flanged roller bearings; the trunnion members abutting against a stationary feed head and a stationary discharge head, the joints being rendered gas-tight by packing. The shell is built up of a number of sections and has longitudinal ribs for the purpose of causing all the material to come into contact with the hot walls of the shell as it rotates.

LEAD SULPHATE; ZINC OXIDE; FURNACES.—W. J. Fadden (*Pat. J.*, No. 1637, 1920). Pat. No. 141,089, Oct. 7, 1918. The production of distillates from mineral matters, such as the production of basic lead sulphate or zinc oxide from sulphide ores by feeding the ore on to a bed of fuel and oxidizing the vapour, the product being passed to cooling and filtering chambers, is effected in apparatus in which the draught through the filters and cooling chambers and the air admitted to the furnace are controlled by means situated at the furnace itself, so that an operator, while watching the flame of the furnace, if necessary, through a spectroscope, can adjust the conditions so as to keep the oxidation constant.

TUNNEL KILNS.—G. H. Benjamin (*Pat. J.*, No. 1635, 1920). Pat. No. 140,578, March 6, 1919. A tunnel kiln is heated by an external combustion chamber and by hot air from externally arranged hot blast stoves. The combustion chamber is of a size to permit free evolution of flame, and contains means, such as a mass of bricks located in line with the burners, to accelerate combustion. The hot products from the combustion chamber are led by flues to the hot-blast stoves, one pair of which is being heated while the other pair is supplying hot air past reversing valves and through flues to outlets at the bottom of the inner walls of the kiln chamber. The hot air, after circulation through the goods, is withdrawn by a longitudinal flue and pump and may be passed to a recuperator. The stoves may also be heated by burners.

CARBONIZING APPARATUS.—H. A. Fawcett (*Pat. J.*, No. 1635, 1920). Pat. No. 140,647, May 20, 1919. Relates to carbonizing apparatus of the type in which the materials are enclosed in a rotary casing and subjected to the action of carbonizing gases, and in which the casing is open at the bottom and is fitted with internal rails supporting a wheeled truck adapted to complete and close the casing and to be locked in closed position, and consists in constructing such rotary casing with circular end-plates mounted on suitably driven grooved friction pulleys.

TUNNEL KILNS.—C. H. Zwermann (*Pat. J.*, No. 1636, 1920). Pat. No. 140,740, Sept. 29, 1919. The invention is described in connection with two adjacent tunnels operating in opposite directions, and relates mainly to (1) the heating of the firing zone and temperature control therein by control of the outlet of hot gases from different points thereof, (2) heating of the pre-heating zone, partly by hot gas flues and partly from the cooling zone of the adjacent tunnel, and (3) means for cooling parts of the tunnel and pre-heating the air for combustion. Three burners supplied from an adjacent gas producer deliver at the top of the tunnel, and the hot gases, deflected downwardly through the goods, are drawn off at the bottom into three flues arranged below the burners. These flues open respectively from the three sections of the firing zone fired by the three burners, and thus by controlling the draught therein (by dampers at the chimney end), localized

temperature control is effected. The three flues on their way to the chimney are carried in a recess in the pre-heating zone where they are constructed of short sections mounted in transverse walls, and set up a hot-air circulation through the goods.

FURNACES FOR METAL-HEATING, GLASS, POTTERY, ETC.—J. R. C. August (*Pat. J.*, No. 1632, 1920). Pat. No. 139,276, Feb. 12, 1919. In a gas-fired furnace for hardening or tempering steel tools, or for heating or annealing metals, glass, pottery, etc., regeneratively heated gas and air are supplied through pipes to a combustion chamber having inclined sides and floor upwardly inclined towards the outlet leading into the pre-heating chamber, which is in communication with the hardening chamber. The roof of the combustion chamber is rounded and serves to deflect the gas downwardly. The combustion products from the furnace escape into a hood which encloses the air regenerator tubes cast integrally with headers and with the hood. The gas is heated in pipes arranged above the air conduits. A similar combustion chamber is arranged on the opposite side of the pre-heating chamber.

GAS MANUFACTURE.—L. J. Terneden and P. J. Kummel (*Pat. J.*, No. 1634, 1920). Pat. No. 140,090, March 9, 1920. Steam is supplied to vertical gas retorts through vertical flues located between adjacent retorts and having a number of lateral openings. The flues are also used for the withdrawal of gas from the retorts.

TUNNEL FURNACES.—D. M. Cunningham, and Stein & Atkinson (*Pat. J.*, No. 1634, 1920). Pat. No. 140,238, April 23, 1919. A furnace for the annealing or other heat-treatment of metals comprises two or more independently heated chambers, of which one is a main heating or annealing chamber and another a cooling chamber arranged in line and having doors so that the goods can be moved directly from one chamber to the next, the main heating chamber having in connection with it a recuperator of the kind in which the products of combustion flow horizontally and the air or gas (or both) to be heated flow vertically.

ROTARY KILNS.—H. Fenton and A. W. H. Vivian (*Pat. J.*, No. 1635, 1920). Pat. No. 140,514, Dec. 21, 1918. A kiln of the kind having an inclined revolving cylinder is fired alternatively by one or more liquid-fuel burners arranged at one end in openings, or by coal fires on grates, one on either side, with flues opening laterally into the intermediate chamber (within the cylinder).

CLEARING REGENERATORS.—Anon. (*Sprech.*, **53**, 216, 1920). Practical experience extending over many years has convinced the writer that there is no simplified way of clearing regenerators. The trolley system is not satisfactory, since, as every expert knows, the clogging commences on the walls of the chamber, so that the outer bricks eventually become firmly attached to the walls, and the trolley cannot then be easily withdrawn.

ECONOMIC WORKING OF PORCELAIN KILNS.—F. Rohrwasser (*Sprech.*, **53**, 249, 1920). Economies can be effected by using low grade fuels and by the utilization of the waste heat, but this can only be done by combining the gas-firing principle with the tunnel kiln, or with some form of the Hoffmann kiln. The writer claims to have effected this combination in his "group" kiln, which saves fuel to the extent of at least 30%, in addition to the economy realised by utilizing the cheapest local fuel.

FIRING HOFFMANN KILNS.—R. Seydel (*Tonind. Ztg.*, **43**, 643—4, 657—8, 1919). A short account of the precautions which should be taken to ensure proper and economic firing.

COKE FOR HOFFMANN KILNS.—Loeser (*Tonind. Ztg.*, **43**, 699—700, 1919). Small coke may be distributed among the bricks and the kiln fired with coal in the usual way. When a sufficiently high temperature is reached, the coke will tend to maintain and spread the heat in the kiln.

PEAT FOR THE GLASS INDUSTRY.—A. F. Wuromus (*Sprech.*, **53**, 47, 1920). A description—with sketches—of a method of firing with peat.

PORCELAIN TUBES; PREVENTION OF WARPING.—(*Sprech.*, **53**, 52, 1920). Porcelain tubes, measuring 15 cm. in length, 45 mm. outer diam., and from 4 to 7 mm. thickness, may be fired in a suspended position, to prevent warping in the fire, and weighted at their lower extremity by a piece of clay, which can be sawn off afterwards. If unglazed, they may also be fired in saggars if completely covered with dry sand. The warping is due to faulty turning, and can only be avoided by expert workmanship.

GLASS MELTING FURNACES.—(*Sprech.*, **53**, 66, 1920). Indicates methods of economising in fuel.

GASIFICATION OF PEAT IN GENERATORS WITH HORIZONTAL ROTARY GRATES.—M. Reiboldt (*Sprech.*, **53**, 75, 1920). The construction of the generator must be specially adjusted to the material which is being employed. In view of the high moisture-content of peat, a generator closed to access of air has a high gasification capacity. By means of the horizontal rotary grate the ash can be removed without loss of fuel.

STEAM-JET BLAST OR UNDER-GRATE FANS?.—O. Schott (*Tonind. Ztg.*, **43**, 464—5, 1919). A comparison of the two methods of firing with low-grade fuel. The writer gives the preference to the under-grate fan system as being the more economical of the two.

STEAM-JET BLAST VERSUS UNDER-GRATE FANS.—L. Friedlander (*Tonind. Ztg.*, **43**, 689—91, 1919). Replying to the above, the writer points out the advantages of steam jet blasts with automatic control, so that the blast can be regulated according to the state of the fire.

UNBURNED COAL BELOW THE FIRES.—Anon. (*Tonind. Ztg.*, **43**, 637, 1919). The writer describes briefly his own experience in firing. The usual causes for the formation of coke in the grate, such as dampness in the bottom, too frequent feeding of the fires, too wide spacing of the bars, etc., did not apply in this case. The trouble was found to be due to the custom, which is extensively followed, of heaping up the rubbish lying about the kiln (if this did not suffice, locomotive ashes were added) on to the grate, for the purpose of cooling down satisfactorily.

SOME REMARKS ON ANNULAR KILNS.—R. Seydel (*Tonind. Ztg.*, **43**, 617, 1919). A short general discussion of the subject.

CALCULATION OF THE FUEL CONSUMPTION IN MIXED BURNINGS OF BRICKS, TILES AND DRAIN PIPES.—G. Paschke (*Tonind. Ztg.*, **43**, 575, 1919).

DETERMINATION OF THE AMOUNT OF DUST IN THE FLUE GASES OF ANNULAR KILNS FOR BURNING PORTLAND CEMENT.—O. Schott (*Tonind. Ztg.*, **43**, 478—80, 1919). As the result of careful observations, it was found that 1000 litres of the flue gas contained on an average 0·5287 gr. solid matter, of which 87·8% was soluble and 12·2% insoluble in water. The insoluble portion consisted mainly of the ingredients of cement. The amount of water in the flue gases was found to be 36 gr. per 1000 litres, or 600 times the amount of cement dust. The article indicates a method of calculating the various factors.

DRAUGHT TROUBLE IN ANNULAR KILNS.—Anon. (*Tonind. Ztg.*, **43**, 499—500, 1919). The cause of insufficient draught in annular kilns is often due to the firing chamber being too short and the flues and chimney being of wrong dimensions. The firing chamber should be at least 80 m long.

TAR-OIL INSTEAD OF COAL.—A. Schmid (*Tonind. Ztg.*, **43**, 308—10 1919) A short description (illustrated) of the methods of oil-firing

ROUMANIAN STOVES.—K. Jacob (*Tonind. Ztg.*, **43**, 140, 1919) The stoves consist of a tall, central portion, under which is the grate with two

hollow columns, one on either side, connected with the central chamber. The gases of combustion pass up the centre and down the two columns before reaching the chimney. The grate and the central portion are usually built of grog brick, the two columns consist of thinner grog material. The purpose of the side columns is to increase the heating surface, while the heavier central portion serves to store up the heat and maintain an even temperature.

MANUFACTURING PROCESSES: GLAZES, ENAMELS.

THE EFFECT OF ZINC, IN THE FORM OF VARIOUS COMPOUNDS, UPON A CHROME-GREEN GLAZE.—(*Sprech.*, **53**, 215, 1920). Taken mainly from R. H. Minton's paper published in the *Trans. Amer. Cer. Soc.*, **17**, 667, 1915.

THE ART OF ENAMELLING OR THE COATING OF IRON AND STEEL WITH GLASS.—R. F. Nailler (*Sprech.*, **53**, 225, 1920). Taken from *Metallurgical and Chemical Engineering*, **11**, 695—8, 1913.

THE INFLUENCE OF METALLIC CHLORIDES ON THE VOLATILIZATION OF IRON OXIDES IN ENAMELS.—(*Sprech.*, **53**, 298, 1920). Taken from a paper by G. A. Bole and R. M. Howe, published in the *Trans. Amer. Cer. Soc.*, **17**, 125, 1915.

THE USE OF ENAMEL IN THE GERMAN ARTIFICIAL JEWELLERY INDUSTRY.—M. Herzel (*Sprech.*, **53**, 375, 1920). The enamel is bought ready prepared by the manufacturers of artificial jewelry. It is first broken up in steel mortars and then mixed with distilled water and a few drops of nitric acid, and pulverised in a porcelain dish. When turbid, the water is poured off, and fresh added. Small portions only are ground at one time. Wet-ground enamel deteriorates rapidly in the air and becomes dull. It must, therefore, be applied quickly to the metal, and fired when dry. The metals must be specially prepared. Gold and Silver may be polished and scoured, or dipped in acids (dilute sulphuric). Copper and nickel-plated ware is dipped in a mixture of concentrated sulphuric, concentrated nitric, salt, and a little pine soot. For the cheaper varieties of brooches, etc., iron is now often used. It is first dipped in a mixture of 1 part conc. sulphuric acid and 5 parts water. The ware is fired first in the muffle, followed by a second or "finishing" firing.

PREVENTION OF DEVITRIFICATION OF GLAZES.—R. Berg (*Sprech.*, **53**, 19—21, 1920). A certain glaze (the composition of which is not given) which had long been in use with stoneware utensils, was tried with wall tiles. Though fired under the same conditions of temperature, etc., the glaze on the tiles exhibited a "dead" surface. Attempts were made to discover and remove the cause of this trouble by varying the fusibility of the glaze. The glaze in question was formed of a certain frit (F.1.) containing 2·578 equivalents of silica and 0·192 Al_2O_3; the glaze itself (G.1.) contained 2 599 SiO_2, O 0 326 Al_2O_3. After numerous trials with varying proportions of the constituents, the writer came to the conclusion that the trouble was caused by part of the flux in the glaze being absorbed by the porous body of the tiles. To overcome this, the glaze had to be given more of an enamel character, in order to render the surface tension of the glaze greater than the absorbing capacity of the body. For this purpose zinc oxide, calcium oxide and alumina were available. Five per cent. zinc oxide was added to frit F.1. to form frit F.9., containing 0·154 equiv. Al_2O_3 and 2·04 SiO_2, and the glaze made from this gave a perfectly satisfactory surface. For coloured tiles, further experiments were tried with CaO and Al_2O_3. The final result was a frit of the following composition:

$$\left.\begin{array}{l} 0{\cdot}44\ PbO \\ 0{\cdot}35\ CaO \\ 0{\cdot}11\ Na_2O \\ 0{\cdot}10\ K_2O \end{array}\right\}\ 0{\cdot}19\ Al_2O_3\ \left\{\begin{array}{l} 2{\cdot}14\ SiO_2 \\ 0{\cdot}30\ B_2O_3 \end{array}\right.$$

the glaze from which gave satisfaction in every way.

SLIP GLAZES.—F. Richter (*Tonind. Ztg.*, **43**, 46, 1919). For certain bodies, the following glaze is recommended, fired at about cone 8:

Silica	66·23 per cent.
Clay	15·74 ,,
Iron oxide	3·61 ,,
Calcium oxide	3·52 ,,
Magnesium oxide	2·98 ,,
Alkalis	1·22 ,,
Loss on firing	6·70 ,,

As a salt glaze, this gives a good red brown gloss at about cone 6—7.

FISH SCALING.—J. B. Shaw (*J. Amer. Cer. Soc.*, **3**, 489, 1920). Fish scaling is a defect very common in sheet steel enamelling, and practically unknown elsewhere. It appears as small pits, usually semi-circular, resulting from a speck of ground coat enamel jumping off, usually leaving the bright steel exposed. The pits are sometimes very numerous and very small, sometimes less numerous but larger (1/16 to 1/4 inch in diameter).

Fish scaling is purely a ground coat defect, and very rarely occurs after a second coat has been burned on the ware. It is much more common on heavy gauge steel (20 to 16) than on the lighter gauges (26 to 20). Blistering which is also quite common in steel enamelling, invariably results from impurities rolled into the steel. Another common defect in steel enamelling is the pitting which comes on the ground coat, giving it a scabby appearance.

This defect is due to improper tempering agents which cause rusting under the ground coat in drying, and after firing result in a spot having the appearance of iron scale. This defect can generally be entirely eliminated by tempering the ground coat with borax in the mill or tub.

The results of an extensive but incomplete investigation seem to indicate that the chemical composition of the enamel has very little bearing on the subject of fish scaling. Coarse grinding is universally recognised to give best results in ground coats, and some of the differences were probably owing to larger proportion of fine material obtained in wet grinding samples tested in the factory. The author believes fish scaling to be due to the expansion of gas bubbles (always present) under the enamel, under certain conditions not yet determined.

MANUFACTURING PROCESSES: COLOURS, DECORATIVE PROCESSES, ETC.

PRIME COLOUR CERAMIC PHOTOGRAPHY.—C. Heck (*Sprech.*, **53**, 275, 1920). A general description of the process, which is extensively employed in mass production in America, but little known in Germany.

CERAMIC METAL-TECHNIQUE.—E. Heinecke (*Sprech.*, **53**, 65—6, 1920). A plea for the revival of the old method of decorating ware by applying metal in films of at least 1 mm. thickness to the ware. The design is first painted on in gold and the article fired in a muffle kiln. It is then immersed in a copper bath, until a fairly thick layer of copper is deposited on the gold surface. The design is then completed by an engraver, and finally gilded over by dipping in a gold or silver bath. The writer describes a small Chinese tea-cup, the method of decoration of which he is unable to explain. The outer surface is covered with an extremely fine network pattern, filled in with coloured enamels. A thin, gold, metallic thread runs through the network, and in addition, the cup is decorated with underglaze cobalt colours.

MANUFACTURING PROCESSES: PLANT AND MACHINERY, ETC.

MIXING.—R. B. Grey (*Pat. J.*, No. 1628, 1920). Pat. No. 138,286, Sept. 5, 1919. Relates to mixing apparatus of the vortex type in which the contents of a tank are circulated by a propeller, and baffles, or breakers are provided to break up the streams. The invention consists in making the baffles independently adjustable as to their depth of immersion in the contents of the tank.

MODERN OPEN-AIR DRYING SHEDS.—R. Seydel (*Tonind. Ztg.*, **43**, 310—11, 320—2, 1919). In the first place, the position of the drying shed

must depend upon the direction of the prevailing winds, that is, with the gable ends facing approximately north and south. To avoid unnecessary transport, the press house should be situated near the north end and the kiln house near the south end. The construction of the drying-shed and kiln house is described in some detail.

BRICK MACHINES, ETC.—A. Huart (*Pat. J.*, No. 1632, 1920). Pat. No. 139,244, Dec. 24, 1918. Relates to machines for moulding bricks, etc., of the type comprising a vertically intermittingly-rotated mould-carrier.

BRICK PRESSES.—Etablissements Rouchard et Lamassiaude (*Pat. J.*, No. 1633, 1920). Pat. No. 139,766, Feb. 26, 1920. Bricks are positioned by a reciprocating table in front of the mould, and are transferred thereto by a plunger, which is then held by a sliding locking-plate whilst pressure is applied by a second plunger operated by an eccentric on the main shaft. After pressing, the plate and first plunger are withdrawn, and the finished brick is delivered on to the table by the second plunger.

CASTING POTTERY, ETC.—B. J. Allen (*Pat. J.*, No. 1621, 1920). Pat. No. 136,701, Feb. 6, 1919. Relates to the process described in Specifications 110,649 and 111,643, and consists in providing each mould with an external frame of wood, metal, etc., adapted to slide into the vacuum chamber and to be hermetically enclosed therein by a door.

MOULDING BY CENTRIFUGAL FORCE.—Vickers, Ltd., and N. E. Dufty (*Pat. J.*, No. 1622, 1920). Pat. No. 136,862, Sept. 18, 1918. Relates to the moulding by centrifugal force of articles from materials including formaldehyde condensation products, earthenware, etc., and comprises a device adapted to be rotated at high speed about the axis of the article to be moulded, such device being provided with passages which produce a radical sucking action tending to remove liquid and gas from the material being moulded.

EXTRUSION PRESSES.—G. E. Neuberth (*Pat. J.*, No. 1626, 1920). Pat. No. 137,672, March 11, 1919. An extrusion press for forming seamless metal or paper or like tubes is formed with a slightly tapered core which is adapted to facilitate the extrusion process. Means are provided for centring this core, and it may be formed with more than one degree of taper.

MIXING.—W. J. Coles and E. Allen & Co. (*Pat. J.*, No. 1621, 1920). Pat. No. 136,758, May 19, 1919. In a machine for agitating cement slurry, crushed ore, or other more or less finely divided material in suspension in a liquid, one or more jets of gas are employed in combination with a mechanicallyactuated stirrer. The distributing system for the gas is carried by, and rotates with, the stirrer, and is readily detachable from the stirrer. Gas agitates the material settled at the bottom of the tank, thus reducing the resistance offered by such material to the rotation of the stirrer.

DESIGN FOR A FIREBRICK PLANT.—R. H. Minton (*J. Amer. Cer. Soc.*, **3**, 440, 1920). Relates to a plant designed to use the dry-press process for plastic fireclays, and to combine as far as possible: (1) nearly automatic working, to minimize labour; (2) efficient working, and compact housing, to limit capital investment; (3) utmost efficiency in drying and burning. These points are equally important in other clay-working plants.

The arrangements in connection with clay storage, preparation, rotary dryer, dry press, dryer, firing process, fire boxes (it was found necessary to reconstruct the fire box some 20 times before the right proportions were obtained), etc., are described, and some of them illustrated. The economy of kilns, and forced draught in kilns, are discussed, and it is concluded that a plant according to this design should be able to operate with a low labour element on account of the semi-automatic machinery equipment and the simple method of manufacture. Because of the efficiency of the kilns the important item of burning cost should be as low as is possible with the use of periodic kilns.

SPARKING PLUGS.—The following patents published in the first half of 1920 in the Patent Journal (Nos. 1616 to 1641) relate to these: 134,689, Nov. 30, 1918, and 134,723, Feb. 14, 1919 (No. 1616); 135,031, Jan.13, 1919, 135,042, Jan. 18, 1919, and 135,154, Sept. 5, 1919 (No. 1617); 135,492, Nov. 18, 1919, 135,661, Dec. 13, 1918, and 135,735, March 7, 1919 (No. 1619); 136,109, June 6, 1919, 136,115, June 21, 1919, 136,117, June 24, 1919, 136,247, Dec. 9, 1918, and 136,327, Jan. 8, 1919 (No. 1620); 136,567, Dec. 12, 1919, 136,798, July 18, 1919, 136,801, Oct. 30, 1919, 136,811, Nov. 26, 1919, and 136,851, Sept. 18, 1918 (No. 1621); 137,008, June 13, 1919 (No. 1622); 137,177, March 11, 1919 (No. 1623); 137,254, Aug. 6, 1919, and 137,372, Jan. 13, 1919 (No. 1624); 137,816, Dec. 20, 1919 (No. 1626); 137,967, April 4, 1919, 138,008, June 2, 1919, 138,023, June 30, 1919, 138,037, Aug. 18, 1919, and 138,108, Jan. 21, 1920 (No. 1627); 138,584, April 23, 1919, and 138,596, Dec. 22, 1919 (No. 1629); 138,825, Aug. 27, 1919 (No. 1630); 138,934, Feb. 12, 1920 (No. 1631); 139,483, Feb. 24, 1920 (No. 1632); 139,816, March 5, 1920, and 139,933, April 22,1919 (No. 1633); 140,172, Feb. 15, 1919, and 140, 382, Feb. 17, 1920 (No. 1634); 140,900, March 28, 1919 (No. 1636); 141,074, April 1, 1920 (No. 1637); 141,435, Jan. 15, 1919 (No. 1638); 141,637, Nov. 22, 1919, and 141,740, April 16,1920 (No. 1639); 141,877, March 25, 1919, and 141,975, July 10, 1919 (No. 1640); 142,180, Jan. 28, 1919, and 142,396, Oct. 8, 1919 (No. 1641).

MOULDING TILES.—A. Muller Bauten and Industriewerke (*Pat. J.*, No. 1634, 1920). Pat. No. 140,384, Feb. 26, 1920. Relates to combined tamping and striking-plates for tile machines.

THE CARE OF MACHINERY.—K. Wachwitz (*Tonind. Ztg.*, **40**, 523, 1916). On the proper cleaning and oiling of machinery, bearings and shafting, attention being drawn to points often neglected. P.W.T.

MECHANICAL EFFICIENCY OF BRICK PRESSES.—C. A. Kierling (*Tonind. Ztg.*, **40**, 725, 1916). P.W.T.

BUCKET CONVEYORS.—Randolf (*Tonind. Ztg.*, **43**, 586, 1919). A description (with illustration) of a modern apparatus, the belt of which can easily be detached at the bottom guide-pully which is not fixed but moveable in a vertical plane.

AN EFFICIENT AIR SEPARATOR.—Anon. (*Tonind. Ztg.*, **43**, 669, 1919). Air separators, as introduced about 30 years ago by a German firm (Gebr. Pfeiffer), have undergone considerable improvement since then. Their great advantage is their small compass; no chambers are required for settling the dust, as the separation takes place in the apparatus itself. The machine is fed through a hopper at the top; the material is dispersed in all directions by the distributor, so that the fine dust, meeting the upward current of air, is carried to the fans, which force the mixture into the outer chamber. Here the dust settles and is collected at the bottom, while the air returns to the inner separating chamber, thus subjecting the falling coarse particles to a further sifting.

For very fine sifting a number of horizontal plates are fitted between the distributor and the fans. In passing between these plates, the coarser particles are separated from the dust-laden air current before the latter passes into the outer settling chamber. The fineness can be regulated by raising or lowering the distributor, instead of altering the speed of revolution.

AIR-SEPARATORS.—(*Tonind. Ztg.*, **43**, 349—50, 1919). The practical difficulties in connection with the conical air separator, such as the regulation of the air current, and the necessity for grinding the dried clay to the proper degree, have hitherto prevented a wider use being made of the machine. For clays containing sulphur the old method is undoubtedly the better.

III.—FINISHED PRODUCTS: TESTING, ETC.

TENSILE STRENGTH OF REFRACTORY MATERIALS.—M. W. Travers (*J. Soc. Glass Tech.*, **4**, 138, 1920). The author states that in modern glass furnaces, working at high temperatures, failures are generally to be attributed to the fact that the materials are in tension rather than under load, and mentions several examples.

The ratio of the numerical values of the tensile strength to the resistance to crushing stresses for materials such as stone and marble is about 1 to 20. But in the case of refractory materials at high temperatures the structure is almost invariably composed of solid particles in a glassy matrix, the solid particles being insoluble, crystalline material which is present in the refractory before it is burned, or which is formed *in situ*. Purdy's ideal refractory consisting of a high percentage of very infusible material, carefully graded, and bonded with a very small quantity of vitreous bond, may answer for refractory materials designed to withstand crushing load, but it does not follow that it will withstand tensile stresses equally well. According to the author, the ideal refractory consists of a system oî interlocking crystals, formed *in situ*, in a glassy matrix. If the matrix is such that it forms a *Sillimanite* layer in contact with alkaline fluxes, corrosive attack by glass may be largely discounted. The *Sillimanite* layer appears to be sufficiently impervious to delay, very considerably, the mixing of the liquid phases on either side of it.

FIRECLAY REFRACTORIES UNDER LOAD.—A. S. Watts (*J. Amer. Cer. Soc.*, **3**, 448, 1920). Relates to a possible explanation of failure under load at high temperature. Bleininger and Brown concluded that failure at 1300°C. under a 75 lb. per square inch load will result from a total flux content of 0·225 molecular equivalent or more, regardless of the content of silica, but calculating the alumina as 1. The failure is ascribed chiefly to inferior bond clay, oftener owing to high flux content than to high silica content—resulting in development of easily fusible silicates at low temperatures and the progressive solution of additional silica and alumina with increased temperature or with a prolonged exposure to the same temperature. Most premature failures undoubtedly arise in this way, but the author states that every user of fireclay bricks is aware that the bricks begin to weaken mechanically under load at a temperature below 1300°C., no matter how low the alkali content or how nearly the Al_2O_3—SiO_2 formula approaches that of pure Kaolinite. Cases are cited in which bricks began to deform under load at 1291°C., 1207°C., and 1213°C., though the actual fusing temperatures were about 1695°C., 1685°C., and 1685°C. respectively, and in another case there was no tendency to deform under the load test, though the actual fusion temperature was only about 1650°C. All four of these refractories contained less than one per cent. flux, and the difference in behaviour can only be due to either the low alumina or high silica of the last mentioned.

Study of the foregoing and other data suggested to the author the possibility of the weakness of highly aluminous clay refractories being due rather to a period of physical weakness produced in the mass by the decomposition of the kaolin and the recombination of the alumina and silica as sillimanite than to the progress of pyrochemical solution. Crystallization in masses of metal is recognised as a direct cause of mechanical weakness, and the change of crystal form in silica explains the failure of silica refractories. According to Glasenapp, all clays become crystalline at high temperature coincident with the decomposition of the clay substance, sillimanite being apparently produced merely by molecular rearrangement without fusion. Zoellner found that kaolins fired at Cone 15 yielded 20 per cent. sillimanite, but that ball clays, which vitrified at cone 15, yielded less than 6 per cent. sillimanite.

For increasing the durability of saggars and facilitating the use of the saggar machine, increasing amounts of ball clays (of poor colour but good

refractory value) have been used. Addition of even very refractory fireclay has been found injurious. The only other clay found suitable for mixing was a highly siliceous clay (wad clay, etc.) In the Eastern states a highly siliceous kaolin in crude form (called "spar") is used, and in Ohio a highly siliceous but refractory flood, plain clay. In both cases the saggars are far superior to anything produced from best flint clays and plastic fireclays. The saggars containing fireclays are mechanically weak and crack after a few firings at best while properly made ball clay saggars seem to last almost indefinitely unless broken in handling.

TESTING HARDNESS OF MATERIALS.—L. Johnson and H. Brearley (*Pat. J.*, No. 1634, 1920). Pat. No. 140,165, Feb. 8, 1919. A hardness-testing machine comprises a member supporting a hardened steel ball, a lever carrying the member, an eccentric connected with the lever for applying a predetermined load, and a second eccentric connected with the lever and with a second lever or lever system controlled by a weight. The specimen is placed on a base and is engaged by a hardened steel ball mounted at the end of a screwed spindle carried in a nut pivoted to a lever. This lever is connected at one end to an eccentric strap mounted by ball bearings on an eccentric carried by a shaft on which a hand-lever is mounted. The other end of the lever carries an eccentric strap mounted by ball bearings on an eccentric on a shaft, on the end of which is mounted a lever carrying a weight. The load is applied by turning the hand-lever, a pawl engaging a toothed segment carried by the lever when the maximum load is reached. A second pawl may be moved into engagement with the segment to hold the lever in this position.

TESTING PHYSICAL QUALITIES OF MATERIALS.—R. Guillery (*Pat. J.*, No. 1637, 1920). Pat. No. 141,043, March 29, 1920. In a testing machine, the elastic limit of the specimen is determined by causing to act on a column of water two opposite forces, one proportional to the deformation of the specimen, and the other to the load, the point at which alteration in the height of the column takes place giving the elastic limit, while the adjustment of the force due to the load gives the modules of elasticity.

HARDNESS-TESTING MACHINES.—W. & T. Avery, and H. N. Cox (*Pat. J.*, No. 1641, 1920). Pat. No. 142,323, May 27, 1919. Apparatus of the kind employing a hardened ball which is forced into the material to be tested comprises means whereby the load applied to the test piece is transmitted through a system of levers to two counterweighted levers.

TESTING HARDNESS OF MATERIALS.—F. C. Fairholme, W. H. Hatfield, and G. Stanfield (*Pat. J.*, No. 1620, 1920). Pat. No. 136,129, Aug. 22, 1919. A portable tongs-shaped device for hardness-testing on the Brinnell system has a powerful spring mounted under compression within the bowed end of one of the handles, the compression on which is relieved by a hand-lever and co-operating spindle so that the spring exerts its influence to move the jaws of the device together.

POROSITY AND VOLUME CHANGES OF CLAY FIRE BRICKS AT FURNACE TEMPERATURES.—G. A. Loomis (*U.S. Bur. Stand. Tech. Paper*, **159**, 1920). In addition to the tests in general use, viz.: chemical analysis, direct determination of the softening point, and resistance under load at high temperature, the determination of the porosity and volume changes is very valuable in the study of the fundamental properties of clay fire bricks, a better knowledge of which is essential for complete and satisfactory classification. Investigations were therefore undertaken by the writer to study the fundamental properties of clay fire bricks by a comparison of their changes in porosity and volume on heating to different temperatures with the results of a specific load test and with the softening points. The methods applied for this purpose are outlined in some detail.

Determination of Porosity and Volume Changes. For each brand of fire brick, 6 briquets, measuring approximately $2\frac{1}{2}$ by $1\frac{1}{4}$ by $1\frac{1}{4}$ inches, were used for experimental purposes. The initial porosity was determined on two of these small specimens by first weighing after drying at 110°C. and then finding the wet weight and the suspended weight after saturating in boiling water under a vacuum, represented by a 24 inch mercury column, for four hours. The per cent. porosity was then determined from the Purdy formula:

$$\frac{\text{Wet weight—dry weight}}{\text{Wet weight—suspended weight}} \times 100 = \text{per cent porosity.}$$

The volume of the six briquets was then accurately determined in a volumenometer of the Seger type after soaking in oil.

In burning the briquetes, the temperature was rapidly brought up to 250—300°C. and held for 3 or 4 hours to vaporize the oil. Over night the temperature was brought up to 800°C., and then rapidly raised to 1200°C. The firing was then conducted at the rate of 30°C. per hour to 1500°C. The deformation of the standard cones was as follows:

Cone 13 down at	1350°C.
,, 15 ,, ...	1450°C.
,, 17 ,, ...	1500°C.
,, 18 half down at	1500°C.

After the burning, the porosity of each briquet was determined as before, as also the final volume.

Method of Making Load Test. A load of 40 pounds per sq. inch at 1350°C. was employed for $1\frac{1}{2}$ hours on a standard-sized brick of each brand. The usual rate of firing up to 1350°C. was followed. The thermocouple was placed within half an inch of the bricks in a porcelain protecting tube.

Method of Determining Softening Points. Portions of the bricks were ground up to pass a 60-mesh screen and moulded with gum tragacanth into cones of the size of the Orton higher pyrometric cones. These were fired in a small pot furnace, using a Fletcher blast burner with natural gas and compressed air. The time of firing was limited to $1\frac{1}{2}$ to 2 hours, and the results were expressed in terms of the corresponding standard cones.

Results. The results of the determinations of the changes in porosity and volume, the load tests, and the softening points are tabulated. Most of the bricks were of a nonsiliceous character. A chemical analysis was made on those few bricks which were apparently of a siliceous nature. This analysis, together with the results of the tests on these specimens, are given in the following tables:

Table 1.

PARTIAL CHEMICAL ANALYSIS OF SOME OF THE BRICKS TESTED.

Laboratory No. of Brand	SiO_2	Al_2O_3 + TiO_2	Fe_2O_3	CaO + MgO + Na_2O + K_2O	Total fluxes excl. TiO_2, but incl. iron as FeO
	Per cent.	Per cent.	Per cent.	Per cent. by diff.	Per cent.
11	65·93	31·31	2·96	—	1·33
18	80·56	18·69	1·15	—	0·52
19	69·92	28·45	2·00	—	0·90
22	67·47	30·38	1·48	0·67	1·33
23	75·66	21·69	2·22	0·43	1·43
24	60·07	34·88	2·22	2·83	3·83
46	73·37	24·55	2·39	—	1·07

Table 2

POROSITY AND VOLUME CHANGES UP TO 1400°C.

Lab. No.	Process of Manufacture	Per cent. initial Porosity	Per cent. Porosity at 1300°C	Per cent volume change at 1300°C.	Per cent. Porosity at 1350°C	Per cent volume change at 1350°C.	Per cent. Porosity at 1400°C	Per c vol chan 140
11	Stiff mud..	18·03	17·45	—	16·15	−0·40	15·00	—
18	Dry press, using two plastic clays	25·32	25·15	−0·20	25·20	—	25·60	+
19	Stiff mud, using mixture of plastic and flint clay	26·65	26·50	—	26·25	−0·25	25·90	—
22	Stiff mud, using mixture of clays	23·07	22·70	−0·25	22·35	−0·35	22·40	−
23	do. do. ..	19·08	18·75	+0·20	18·05	+0·30	17·80	−
24	Dry pressed, using one clay	19·54	18·90	+0·25	19·15	+0·10	18·50	+
46	Stiff mud	22·15	20·85	+0·30	19·80	—	18·15	−

Summary.

1. Bricks which are capable of withstanding a pressure of 40 pounds per sq. inch at 1350°C. generally show slight changes in volume or porosity when burnt at temperatures up to 1425°C.

2. The greater number of the bricks which failed to pass the load test show rather marked change in volume or porosity at some temperature below 1425°C.

3. Bricks which show distinct overburning by pronounced expansion at temperatures below 1400°C. invariably fail in the load test. The adoption of a definite limit for the permissible expansion within the given temperature range is particularly important for detecting inferior clay refractories.

4. The changes in volume and in porosity of bricks burnt at some temperature between 1350° and 1425°C. serves, in a measure, as a criterion of their ability to pass the load test.

5. Most of the bricks which show a porosity decrease not exceeding 5% and a volume change not exceeding 3% (approx. 1% in linear dimensions), when burnt at 1400°C., will pass the load test.

6. Bricks which show a decrease in porosity exceeding 5%, or an expansion or contraction in excess of 3% by volume (1% in length) at 1400°C., in nearly all cases failed to pass the load test.

7. The use of limiting porosity and volume changes for fire clay bricks burnt at 1400°C. would serve as a means of eliminating from consideration a large number of bricks which fail in the load tests.

8. Bricks which fail in the load test owing to failure in the bond may not show marked changes in volume or porosity in burning, but often show very low cold crushing strength.

9. No definite relationship seems to exist between the softening point of a brick and its ability to withstand load at high temperatures. But all bricks which softened below cone 28, whether siliceous or not in character, failed completely in the load test. Cone 28 appears to be the minimum softening point for clay fire bricks. It is probable that bricks containing less than 65% SiO_2 should have a minimum softening point of cone 31.

10. Bricks with an initial porosity below 21·5% and with an average decrease of about 6 points in percentage of porosity, contracted about 5·5% in the load test. Bricks showing an average porosity about 21·5% showed a like contraction in the load test with a change of about 3 points in porosity percentage.

TABLE 3

POROSITY AND VOLUME CHANGES ABOVE 1400°C.

Lab. No.	Per cent. Porosity at 1425°C.	Per cent. volume change at 1425°	Per cent. Porosity at 1450°	Per Cent. volume change at 1450°	Per cent. Porosity at 1500°	Per cent. volume change at 1500°C.	Points decrease in Porosity from initial to 1425°C.	Points decrease in Porosity from initial to 1450°C.	RESULT OF LOAD TEST: deformation in inches and per cent.	Softening Point Cone
11	14·30	−0·25	13·25	−0·50	11·35	−0·50	3·73	4·78	0·28 inch = 3·23 per cent.	29¼
18	25·85	+0·40	25·85	+0·60	24·75	+0·25	+(0·53)	+(0·53)	0·01 inch = 0·11 per cent.	29¼
19	25·60	−0·50	25·05	−0·90	21·60	−3·40	1·05	1·60	0·21 inch = 2·37 per cent.	31
22	22·30	−1·25	21·35	−2·25	15·50	−5·85	0·77	1·72	0·23 inch = 2·56 per cent.	31
23	17·40	−0·50	15·35	−1·25	10·75	−2·00	1·68	3·73	0·10 inch = 1·11 per cent.	28
24	17·80	+0·30	17·05	+0·15	15·00	−2·75	1·74	2·49	0·57 inch = 6·46 per cent.	31¼
46	17·65	−0·80	17·10	−1·00	14·15	−2·90	4·50	5·05	0·40 inch = 4·47 per cent.	29

THE ACTION OF FERRIC OXIDE ON SILICA BRICKS.—(*Tonind. Ztg.*, **43**, 50—1, 75—6, 1919). A short summary of papers read before the Académie des Sciences (Paris) in May, 1919. (See TRANS. **18**, Abs. 109).

SUITABLE FIREBRICKS.—M. Kämpffer (*Tonind. Ztg.*, **40**, 536, 1916). Mention is made of the usual qualities of these bricks for ovens, linings, etc. Writer considers that firebricks should not be expected to withstand the action of cinders of varying composition, and gives an example of a boiler furnace which was fired with coal having an ash content of 5%. The bricks were satisfactory, and were changed every six months. It was found, however, that durability was low with a coal giving 14% ash.

Composition of cinders.	No. 1	No. 2
SiO_2	61·34	54·21
Al_2O_3	26·42	15·37
Fe_2O_3	6·89	8·01
CaO	1·21	18·15
Alkali	1·43	0.93
SO_3	2·70	3·40

No. 1 acted very little. No. 2 destroyed the bricks quickly, and the more so, the higher the temperature of the grate and neglect in raking-out of cinders. P.W.T.

IMPERVIOUS SAND-LIME BRICKS.—L. Gerber (*Tonind. Ztg.*, **40**, 733, 1916). Increasing the lime content will probably achieve this end (*i.e.*, impermeability to water) although the decrease in strength caused by the increased lime content has not yet been avoided. P.W.T.

SPECIFIC HEAT AND HEAT-CONDUCTIVITY OF REFRACTORY PRODUCTS.—(*Sprech.*, **52**, 499—501, 1919). An article taken from a paper by E. Heyn, O. Baner and E. Wetzel, published by the Berlin Bureau for Testing Materials in 1914. A number of experiments were carried out to determine the internal conductivity of refractory bricks. The test brick was built in between other bricks of the same kind, heat being applied by a refractory plate heated electrically through a granular carbon resister. Temperature was measured by thermoelements at the brick face, and also in borings, situated at distances of 1.5, 3, 5, 7, 10 and 15 cm. from the face.

The experiments showed that the specific heat of the various grog bricks varied only slightly, in spite of the difference in composition. The increase accompanying rising temperature is also practically the same. Similar conditions apply to the Dinas bricks. For magnesite and carbon bricks, the sp. heat is somewhat higher. On the other hand, the variations in the conductivity of the different bricks were fairly considerable. The increase in conductivity resulting from a rise in temperature varies greatly in the various materials. Remarkable changes in the conductive capacity of the bricks took place as the result of the experimental heatings, although the temperatures were lower than those at which the trials were originally burned. Gradually, after repeated heating, the effect of further heating appears to approach a final value. The effect, however, varies with the different types of bricks; the internal conductivity of the grog bricks BC increased continuously, that of brick 4 was practically unaffected, whilst with brick *B* there was actually a tendency towards reduced conductivity, as the result of repeated burnings. Lower conductivity was also noticed in the magnesite bricks under similar conditions. Beyond 1035° the Dinas bricks exhibited a sudden rise in conductive capacity, which may be due to changes taking place in the material.

For industrial purposes, it is of great importance to determine the final value of conductivity. This could best be done by examining the bricks first in the unused condition, and then again after having been in use some considerable time.

The following results were obtained:—

Material	Percentage of Composition	Sp. Gravity	Specific Heat at 200°	400°	600°	800°	1000°	1200°	Conductivity at 200°	400°	600°	800°	1000°	1200°
Grog Brick BC	Appr. 40 Al_2O_3 ,, 57 SiO_2	1·88	0·225	0·250	0·272	0·287	0·298	0·305	0·0014	0·0018	0·0022	0·0024	0·0026	0·0072
Grog Brick A	30·42 Al_2O_3 63·23 SiO_2 1·98 Fe_2O_3 0·5 CaO 0·25 MgO 3·45 K_2O	1·3	0·216	0·254	0·273	0·287	0·295	0·300	0·0011	0·0014	0·0016	0·0019	0·0021	—
Grog Brick B	24/34 Al_2O_3 71·05 SiO_2 2·46 Fe_2O_3	1·77	0·217	0·243	0·263	0·281	0·295	0·304	0·0009	0·0011	0·0012	0·0013	—	—
Grog Brick C	Ap. 25 Al_2O_3 73·7 SiO_2 ,, 1·34 flux	1·90	0·223	0·262	0·284	0·291	0·292	0·293	0·0021	0·0024	0·0027	0·0027	0·0027	0·0027
Dinas Brick	1·56 Al_2O_3 96·92 SiO_2 0·62 Fe_2O_3 0·97 CaO MgO trace	2·04	0·237	0·270	0·282	0·285	0·288	0·291	0·0013	0·0016	0·0017	0·0017	0·0018	0·0021
Magnesite Brick	88·85 MgO 9·31 Fe_2O_3 0·35 CaO 0·17 Al_2O_3 0·20 SiO_2 Insol. in HCl: 0·63%	2·35	0·258	0·275	0·291	0·307	0·324	0·340	0·0011	0·00115	0·0012	0·0013	0·0014	0·0014
Carbon Brick	Coke and Tar	1·27	0·312	0·358	0·377	0·395	0·412	—	0·0012	—	—	—	—	—

In the above table the inner heat conductivity is reckoned in gram-calories centimetres and seconds; to convert into conductivity per Kg. metre and second, the above figures must be multiplied by 360.

SLAG ATTACK ON REFRACTORY BUILDING MATERIAL.—(*Tonind. Ztg.*, **43**, 208, 1919). A short article dealing with the subject in general terms.

IV.—MANAGEMENT, ORGANISATION, COSTING, ETC: COMMERCIAL.

DOES IT PAY TO IMPROVE CLAYS?.—R. Seydel (*Tonind. Ztg.*, **43**, 553, 1919). In choosing the site for a brick works, too little attention is often given to the character of the local clays. If these prove unsatisfactory, so that, in spite of very careful preparation and expert firing, it is found impossible to obtain a sufficiently hard-fired brick or a straight tile, further time and money should not be wasted on the clays, but an attempt should be made to improve the quality by the addition of a suitable clay obtainable at not too great a distance from the works. If this is not possible, the prospects of ultimate success must be considered as very remote.

SPECIMEN WORKS-REGULATIONS.—Anon. (*Sprech.*, **53**, 399, 1920). In conjunction with the more important employers' and workers' federations, the German Labour Ministry has compiled a specimen draft for the guidance of those works, employing a minimum of 20 workpeople, which have to draw up statutory regulations before September 1st. Part I. of the draft deals with the engagement of employees, and specifies that the date when the workman is to commence must be agreed upon. The employee must receive a copy of the works regulations and must acknowledge receipt of the same in writing. This constitutes a contract between the two parties. Part II. regulates the conditions for terminating the engagement, fixes the notice period, etc. Part III. deals with the hours of employment, meal times, etc. Parts IV. and V. give the details of rates of pay, method of calculating piece-work and day-work rates, etc. Part VI. reads: "The workman undertakes to carry out the work entrusted to him, under the direction of his employer or his deputy, to the best of his knowledge and ability. The material received must not be used wastefully. Faulty material, tools or machines must be reported at once. Tools, machines, drawings, models and other equipment must be handled rationally, and with care, and must be kept in their proper places. Each workman undertakes to keep all business and works secrets." The remaining parts of the draft concern matters such as accidents, losing time, supervisory arrangements, etc.

MANUFACTURING STATISTICS.—Anon. (*Sprech.*, **53**, 321, 1920). The object of statistics is to determine the exact amount of wastage, and to enable the management to discover in which department the greatest amount of breakage occurs. Incoming orders are registered in the usual way in the Orders Department, and then passed on, against receipts, to the Statistical Department, where cards are made out, and numbered, for each article. In large concerns it is advantageous to grade the articles according to the method of manufacture, and to appoint a clerk to superintend each grade. Each clerk is then responsible for handing over the order in question, entered on a suitable form, to the foreman. The latter then enters the particulars into a special Work-Book, in which are indicated the name of the workman, date of commencing and finishing the work, date of delivery, etc. The actual work-card, containing the usual information, is passed on to the workman, and travels from one shop to another until it reaches the packing house. Here the individual items are carefully noted on the card, which is then returned to the Statistical Department.

PROFIT-SHARING.—H. Göhring (*Tonind. Ztg.*, **43**, 677—9, 1919). A short historical survey of the subject. The writer concludes that the great

amount of propaganda conducted by the advocates of the system has not been justified by results.

THE ROUMANIAN GLASS INDUSTRY.—(*Sprech.*, **53**, 262, 1920). Taken from a report by the Dutch Consul-General in Buckarest. There are at present 9 glass works in Roumania, with an aggregate capital of 2 million lei, employed chiefly in making bottles, lamp-glasses, and plate glass. From Holland, Roumania imports mainly demijohns. Conditions of payment have hitherto been cash in advance or against documents, but these terms are not likely to lead to an extension of trade, and the Dutch manufacturers must fall into line with the more accommodating terms of their competitors. A reliable representative is of the greatest importance. If possible, he should be of Dutch nationality, and well acquainted with Roumanian conditions. He should also be required to undertake part of the guarantee of payment and to share a certain percentage of the losses due to customers' eventual inability to pay.

THE VALUE OF THE WORKS BOOK-SHOP.—Ch. Sieg (*Tonind. Ztg.*, **43**, 646, 1919). "During the turmoil of the revolution, the German workman has lost two precious qualities: industriousness and sense of duty." The writer thinks that the works book-stall, if run on proper lines, would do much to raise the moral standard of the workers.

RE-ORGANISATION OF THE BRICK INDUSTRY.—J. F. Kleine (*Tonind. Ztg.*, **43**, 565, 1919). The article deals with the urgent necessity of re-constructing the brick industry to meet modern conditions, particularly with regard to the coal problem.

THE TAYLOR SYSTEM AND THE BRICK INDUSTRY.—Grüneisen (*Tonind. Ztg.*, **43**, 597, 1919). From its formation, the ordinary brick passes through the hands of at least 12 different men in the course of its manufacture before it reaches the bricklayer. The problem of the industry is to simplify this process. The Gilbreth method is mentioned.

MANUFACTURING COSTS IN THE BRICK INDUSTRY.—G. Hüther (*Tonind. Ztg.*, **43**, 531—2, 1919). A brick works may be divided for the purpose of costing into the following departments: (1) Raw Clay—including purchasing price or rent for pits purchase and carriage of outside supplies; (2) Clay-drawing—cost of labour, tools, etc., in the pit and maintenance of transport from pit to works; (3) Manufacturing Processes—including all expenses entailed in preparation and drying of the clay, cost of labour, fuel and maintenance of machinery; (4) Firing—labour, fuel and repairs are included. Each kiln must be treated separately; (5) Sorting and Loading—including cost of labour and maintenance of railway sidings, loading arrangements, etc; (6) Building Repairs—Cost of Maintenance of Buildings, excluding kilns; (7) General Business Expenses—including salaries, taxes, insurance, travelling expenses, cost of packing, etc.; (8) Interest—including interest reckoned in the usual way on the value of the plant.

The various items are discussed in some detail and the method explained for determining the selling price for 1000 bricks of standard size.

STANDARDISATION IN THE BUILDING INDUSTRY.—K. Matthies (*Tonind. Ztg.*, **43**, 416—7, 1919). In view of the high cost of labour and materials, standardisation of building parts, such as windows, doors, stairs, steps, ceiling parts, fire grates, etc., etc., has now become an urgent necessity. The article points out the various steps to be taken in order to bring about this method of production in Germany.

THE TAYLOR SYSTEM APPLIED TO BRICKLAYING.—C. Sickel (*Tonind. Ztg.*, **43**, 387—9, 1919). A short account of the work done by Taylor and Gilbreth to eliminate waste energy and fatigue.

BRICK MANUFACTURE NEAR PETROGRAD.—A. Behrens (*Tonind. Ztg.*, **43**, 89—90, 1919). From a paper by F. P. Kootunoo appearing in the journal "Sodtshi," 1914.

NEGLIGENCE IN THE USE OF WALL TILES OF BEST QUALITY.—H. Dollinger (*Tonind. Ztg.*, **40**, 478, 1916). In buildings nearing completion, it is often found that expenses must be cut down, and cheap tiles are used in order to economise. These inferior tiles bring the makers into bad repute. P.W.T.

ESTABLISHING THE OUTPUT OF BRICKWORKS.—K. Wendler (*Tonind. Ztg.*, **40**, 721, 1916, and L. Schmelzer, **40**, 861, 1916). P.W.T.

V.—GLASS: GENERAL.

BUBBLES IN GLASS.—Anon. (*Sprech.*, **53**, 376, 1920). Bubbles may be caused by faulty melting processes, or by careless manipulation after melting. With insufficient heat, the glass will not "fine" properly, and tends to become "seedy." The same cause will often produce the so-called "scum bubbles" in the glass. A small piece of iron—a nail, for instance—in the pots, leads to the formation of large bubbles in the glass. If such a nail is not removed at the earliest opportunity, it will eventually cause much damage to the pot.

"SODA COMPOSITION."—L. Springer (*Sprech.*, **53**, 310, 1920). The writer publishes his experiences with certain mixtures recently put on the market under the name of "Soda-Composition," "Glass Composition" or simply "Composition" which were sent to him for analysis and criticism. A certain "glass composition," which according to the producers contained 85% soda, baryta and saltpetre, was found to be almost completely soluble in water and to contain 81% soda, 2% barium peroxide, 0·013% iron oxide, and 16·4% water. The small percentage of barium peroxide in this case scarcely justifies the name "composition." With the necessary adjustments, the mixture might be used simply as sodium carbonate, although for crystal glass purer soda is available. Another mixture under the name of "Glass-Composition and Soda Substitute" gave the following analysis: silica 60·5%, alumina + iron oxide 3·5%, calcium oxide 9·3%, sodium (in glass powder) 20·2%, sodium carbonate 5%, water 1%. Other "Soda Compositions" contained large quantities of rock salt, comparatively little soda, and lime; one, for example, contained 81·3% rock salt, 5·75% sodium sulphate, 7·55% calcium carbonate, 1·8% fluor spar, 2% sodium carbonate, 0·83% insoluble residue, 1·34 water, 0·043 iron oxide. Rock salt melts at about 800°—900°C. and volatilizes rapidly at 1000°C. It is vitrifiable with silica only in the presence of water vapour, and then injurious H Cl fumes are given off. The greatest caution is necessary in employing "Compositions," the chief ingredient of which is rock salt. Small quantities only should be tried at first, as substitutes for soda or sodium sulphate.

Baryta and Fluor Spar in Soda-Compositions. Barium carbonate is a popular substitute for soda and potash. The writer found that by replacing the whole of the lime in a batch with twice its weight of baryta, the mixture melts much more readily and "fines" excellently. With less alkali, the glass still melts easily, but is inclined to be stony. With still more baryta and less alkali, the melting and fining properties are still satisfactory. If the lime is only partially replaced by baryta, the glass melts almost equally as well, but fines much more readily. If only a small fraction of the alkali in a lime-glass is replaced by baryta, the melting becomes more difficult. A saving of alkali can thus only be effected by melting a true baryta glass without lime, or by replacing part of the lime by twice its weight, and a small fraction of the alkali by an equal weight of barium carbonate. 1 kg. fluorspar volatilizes 0·38 kg. sand, 0.72 kg. calcium oxide thereby entering into the composition of the glass. With the addition of fluorspar, the batch melts more readily, and the evolution of silicofluoride

gas effects a satisfactory fining, but the silica content is reduced, and the quality of the glass impaired.

Sulphates as Soda Substitutes. A certain substitute examined by the author contained 94·8% sodium sulphate and the usual secondary ingredients. A purified sulphate free from iron has recently been introduced as a substitute for soda in crystal glass but it is doubtful whether it can be produced more cheaply than soda, and whether the glass made from it would be pure white crystal. Crystallised sodium sulphate has also been put on the market for this purpose. In one sample, the writer found about 50% sulphate with 49·5% water, and a very small percentage of iron oxide. Its use is not recommended for obvious economic reasons.

Sodium Silicofluoride. This and similar fluorine compounds may possibly be present in soda "compositions." Sodium silicofluoride is a by-product of the superphosphate industry. It may be used with kaolin or fluorspar as an opacifying medium. It contains about 33% of sodium, so that about 176 kg. are required for every 100 kg. soda in the batch. It has the same defects as fluorspar, and, if present in large quantities, it tends to render the glass turbid, especially if the batch contains alumina. Sodium silicofluoride was also found by the writer to constitute the main ingredient of the so-called boron and arsenic substitutes, or "fining media."

MOULDING GLASS BEADS.—W. Haunich (*Sprech.*, **53,** 344, 1920). A short, general description of the plant, tools, etc., required for making globular glass beads.

THE MELTING PROCESS IN LOW GLASS POTS.—J. Baldermann (*Sprech.*, **53,** 205, 1920). The writer disputes the opinion that glass cannot be melted without "ground" heat. The low pots should be filled to their utmost capacity with batch, and when this has melted down (after about 3½ hours) the pots should be heaped up again. After another 3 hours, this batch also will be completely melted. If the pot is still not full, a few ladles of cullet may be added.

THE MANUFACTURE OF "MOTHER-OF-PEARL" GLASS. O. Schwarzbach (*Sprech.*, **53,** 251, 1920). The historical development is first outlined. An opalescent effect was obtained by covering a semi-opaque ground glass with half-crystal glass. Both the ground and the case glass had to have the same co-efficient of expansion. German opalescent glass contains 68 parts sand, 21 potash, 5 soda, 5 red lead, 1 saltpetre, 1 borax, 4 calcite, 6—10 bone ash. The decolorising agents are nickel or manganese oxides; the best opacifying medium is cryolite or bone ash, with possibly a little zinc oxide. Cryolite may be replaced by felspar, kaolin or fluorspar. Opal glasses coloured with fluorides tend to fade on repeated heating. If finely ground mica is added to the first "case" glass, and this followed by a second case of crystal glass, a good "mother-of-pearl" effect is obtained, which may be intensified by reheating the glass in a strongly reducing flame.

THE LEAD (OR COMPOSITION) GLASS INDUSTRY.—V. Hannick (*Sprech.*, **53,** 262, 1920). For a long time, the manufacture of lead glass was a French and Italian monopoly, but a competitive industry gradually made its appearance in Bohemia. Lead glass is particularly suited to the manufacture of artificial stones for brooches, etc. Its composition is a strictly guarded business secret. Lead glass has also been employed recently for making small beads for lamp shades.

THE SODA, LIME AND MAGNESIA CONTENT OF A GLASS OF THE TYPE $RO.3SiO_2$.—(*Sprech.*, **53,** 272, 1920). Taken from a paper by C. C. Rand (*Trans. Amer. Cer. Soc.*, **17,** 236, 1915).

SOME REMARKS ON GLASS-BLOWING.—J. Baldermann (*Sprech.*, **53,** 289, 1920).

PHONOLITE IN GLASS MANUFACTURE. Anon. (*Sprech.*, **53,** 227, 1920). Phonolite, as supplied by the Rhenania Chemical Works in Aachen,

contains: alumina 24%, iron oxide 2·3%, lime 1·2%, magnesia 0·3%, potassium 9·5%, sodium 8·1%, silica 50·3%, carbon dioxide 0·2%, phosphoric acid 0·1%, water (moisture and chemically combined) 3·2%. Accordingly, 100 kg. phonolite will replace 50 kg. pure sand and about 36 k.g. sodium sulphate or 27 kg. soda. The high alkali content (17·6%) is an important factor. The following batches, for bottle glass, illustrate the saving in sulphates or soda, by the use of phonolite;

BATCH	Without Phonolite	With Phonolite	Machine Glass	
			Without Phonolite	With Phonolite
	I.	II.	III.	IV.
Sand	1000	850	870	700
Sulphate	220	110	260	280
Carbon	7	5	10	14
Soda	—	—	80	—
Phonolite	—	300	—	280
Yellow marl ..	510	510	400	380
White ,, ..	270	270	300	380
Manganese dioxide	10	10	35	22
Slag	60	—	50	—

THE MARLS CONTAINED	Yellow
Moisture	3·69
Silica	15·23
Alumina	5·97
Carb. of lime ..	44·72
,, magnesia	25·47
Iron oxide	2·18

The chemical composition of these glasses is as follows:

Batch	SiO_2	Fe_2O_3	Al_2O_3	CaO	MgO	MnO	Na_2O K_2O
I. Without phonolite	68·3	2·0	4·9	14·3	3·8	0·6	6·1
II. With ,, ..	65·8	1·8	7·6	14·4	3·8	0·6	6·1
III. Without phonolite	64·0	1·8	4·6	14·3	3·3	1·5	10·5
IV. With ,, ..	60·0	1·8	7·6	15·9	3·1	1·0	10·6

In numbers II. and IV. the ratio of SiO_2 : Al_2O_3 is about 1 :0·07, that is, well below the usual limit. Upon first introducing phonolite into batches, small quantities only should be used and gradually increased in so far as the melting and working properties of the glass permit.

GLASS-DECORATING METHODS.—C. Jung (*Sprech.*, **53**, 107, 1920). A general description of the most common methods in present use.

CALCULATION OF HARDNESS, OR EXPANSION OF GLASS.—L. Springer (*Sprech.*, **53**, 193, 1920). A general discussion, from a practical rather than a theoretical standpoint. The expansion coefficients of the various constituents of glass, as previously calculated by Schott and Winkelmann, Mayer and Havas (*Sprech.*, 1911, No. 13—15), are quoted. From these figures the expansion coefficient of any glass can be reckoned from its composition. The examples given refer particularly to "case" glasses. By a similar method, the effect of the substitution of various oxides on the expansion of a glass can be calculated.

BATCHES FOR LABORATORY GLASS.—(*Sprech.*, **53**, 41, 1920). The following are recommended for laboratory glass: (1) sand 100 kg., boric acid 6 kg., soda 26, potash 16, zinc oxide 18, calcite 16, hydrate of alumina 4 kg., and 20 grams nickel oxide. (2) sand 100 kg., soda 35 kg., potash 8 kg., sodium sulphate 1½ kg., hydrate of alumina 15 kg., zinc oxide 10 kg. boric acid 6 kg., nitre ½ kg., A regular, high furnace temperature is the main point.

THE USE OF SPECIALLY PURIFIED SODIUM SULPHATE FOR MAKING A1 CRYSTAL GLASS.—K. Killer (*Sprech.*, **53**, 93, 1920). Owing to its impurity, commercial sulphate of soda has hitherto not been

employed as a substitute for soda and potash in the manufacture of crystal glass. The impurities usually consist of about 1% free H_2SO_4, 0·50% NaCl, and 0·07—0·13% iron. The writer used a very pure sulphate, supplied by the firm Knothe & Fritsche, in Bodenbach, containing 99 72% sodium sulphate, 0·08% NaCl and 0·0009% iron, with potassium sulphate instead of the more expensive potash, and specially selected charcoal; the glass obtained left nothing to be desired as regards hardness and brilliance.

HOW TO EFFECT ECONOMY IN LABOUR AND INCREASE OUTPUT IN THE BOTTLE MAKING INDUSTRY.—(*Sprech.*, **53**, 33, 1920). A description of an arrangement for automatically oiling the moulds for making bottles and other labour and time saving appliances.

EFFECT OF CRYOLITE ON GLASS POTS.—(*Sprech.*, **53**, 40, 1920). With a batch containing 170 parts sand, 55 soda, 20 cryolite, 20 fluor spar, 56 felspar, for making milk glass for lamps, etc., the pots lasted from 8 to 10 weeks, until artificial in place of natural cryolite was used. The higher fluorine content of the artificial cryolite caused the pots to deteriorate much more rapidly, particularly at the bottom. To strengthen the pots against the action of fluorine, a little powdered graphite should be mixed with the pot clay, and the first meltings should be with an ordinary batch or with cullet, so as to glaze the inner surface of the pots.

THE DIMENSIONS OF GLASS POTS.—J. Baldermann.—(*Sprech.*, **53**, 11—13, 1920). To obtain the best results, *i.e.*, to melt as much glass as possible within a given time, the pots should be relatively low and wide. Cross-sections of 8 different sizes are illustrated, the inner dimensions varying between 1510 mm. wide and 535 mm. deep and 820 mm. wide and 400 mm. deep. The upper parts of the furnace must be re-constructed to suit these measurements. The melting of the glass is mainly effected by heat reflected from the roof of the furnace. It follows therefore, that this must not be placed at too great a height above the pots.

LINING FOR GLASS POTS.—S. R. Scholes (*J. Amer. Cer. Soc.*, **3**, 498, 1920). The usual pot wall was found to have an average porosity of 10 per cent. Heavy potash-lead glass, though not a very good solvent for clay, owing to its density and fluidity readily penetrates the pores of the pot wall, causing the "honeycomb" effect, and loosening portions which pass into the glass to form stones.

The author, after preliminary experiments, found that a mixture of 90 pot batch with 10 felspar formed a very dense body after burning at 1300°C. without being overburned. He applied this mixture to the glass pot by working it into the usual rolls and placing them along the bottom and sides of the pot, as the latter was built, forming a finger-course about half an inch thick up to the level of the molten glass, and carried up with diminishing thickness about eight inches higher. No difficulty was experienced in drying the pot, and a homogenous body was always obtained. It has often been found necessary to reduce the felspar as much as five per cent. The useful life of the lined pot is from two to three times that of the ordinary pots in potash-lead glass. The only difficulty experienced has been cracks forming in the lining due to cooling shocks on charging with cold batch, though not worse than the cracks ordinarily forming in pots. The penetration of glass through these cracks into the less resistant pot wall is the real cause of the final failure of the pots.

GLASS DRAWING.—Virginia Plate Glass Corporation and A. A. Icenhour (*Pat. J.*, No. 1639, 1920). Pat. No. 141,737, April 15, 1920. The pots from which sheet glass is drawn are elliptical in plan, and may taper downwards. The bait bar is about equal in length to the major axis of the pot. The drawing chamber is kept at the desired temperature by gas burners.

GLASS DRAWING.—Empire Machine Co. (*Pat. J.*, No. 1640, 1920). Pat. No. 141,791, Jan. 18, 1919. In apparatus for drawing glass cylinders, of the type in which a lateral air vent controlled by a shutter is employed,

the air-inlet tube is of smaller diameter than the vent and the tube carrying the bait. By this arrangement, an injector action is produced, which tends to keep the diameter of the cylinder constant.

GATHERING MOLTEN GLASS; MOULDING UNDER PRESSURE.—M. J. Owens (*Pat. J.*, No. 1640, 1920). Pat. No. 142,007, Aug. 27, 1919. Relates to the type of automatic machine in which a number of complete units or working heads are carried by a rotating framework, and in which the metal is gathered from the tank, shaped, and the finished article discharged automatically by each unit as it rotates. According to the invention, gathering and pressing mechanism are combined in one machine.

GLASS-BLOWING MACHINES.—W. J. Miller (*Pat. J.*, 1641, 1920). Pat. No. 142,156, Oct. 30, 1918. In a machine for blowing glass articles, and of the particular kind comprising a series of blank and blowing moulds movable step by step to different stations for successive operations, means for blowing the glass in the moulds, and means for transferring the blanks by turning it over independently of the blank mould, to the blowing-mould, means are provided for sucking down the gather by vacuum into the blank and neck moulds.

GLASS MANUFACTURE.—E. H. Langwell (*Pat. J.*, No. 1641, 1920). Pat. No. 142,365, July 9, 1919. Molten glass passes from the furnace through a revolving tube provided with two or more radial nozzles which are successively brought into the delivery position. The nozzles when out of operative position are heated by a gas jet, etc., to remove adhering glass.

GLASS-BLOWING.—J. T. Pullon (*Pat. J.*, No. 1633, 1920). Pat. No. 139,654, April 7, 1919. Relates to machines of the "Schiller" type for making narrow-necked bottles, and particularly to means for sucking the molten metal down into the neck mould.

GLASS DRAWING.—Empire Machine Co. (*Pat. J.*, No. 1633, 1920). Pat. No. 140,029, Nov. 7, 1919. Relates to the automatic control of air admitted to the drawn glass cylinder during the formation of the cap.

GLASS FURNACES.—Corning Glass Works and J. Bailey (*Pat. J.*, 1634, 1920). Pat. No. 140,374, Jan. 17, 1920. In the heat treatment of articles, *e.g.*, electric lamp bulbs, the furnace or leer is in the form of a rotary heated tube along which the articles move either by reason of the conoidal shape of the articles or the conoidal shape of the tube.

CUTTING OR SEVERING GLASS BARS OR TUBES.—Libbey Glass Co. and E. Danner (*Pat. J.*, No. 1634, 1920). Pat. No. 140,440, March 17, 1920. Relates to apparatus for continuously drawing a rod or tube of glass from a forming-apparatus and successively severing it into sections of predetermined length.

ANNEALING FURNACES.—H. M. Thompson (*Pat. J.*, 1636, 1920). Pat. No. 140,817, March 26, 1920. A gas-fired annealing leer, comprising a muffle chamber with a flat floor and roof formed of tiles, is heated by a combustion chamber above the roof at the forward end, and a series of flues leading to a regenerator chamber containing the gas and air supply pipes.

DELIVERING MOLTEN GLASS.—Hartford-Fairmont Co. and E. H. Lorenz (*Pat. J.*, No. 1638, 1920). Pat. No. 141,320, Nov. 12, 1919. Relates to apparatus for feeding to moulding machines, etc., the charges delivered regularly from a tank.

GLASS FURNACES.—J. S. Atkinson, Stein & Atkinson, and T. C. Moorshead (*Pat. J.*, No. 1639, 1920). Pat. No. 141,617, Oct. 11, 1919. In a glass furnace of the kind in which a rotating table and trough (or pots), for the most part within the furnace carry the glass to a gathering or removal point just without the furnace, a gas and/or air recuperator is employed in which the waste products flow horizontally to the outlet chamber, and the air or gas to be heated flows vertically without change of direction.

GLASS MANUFACTURE.—W. J. Miller (*Pat. J.*, 1621, 1920). Pat. No. 136,816, Dec. 10, 1919. Relates to a machine for the manufacture of pressed glassware.

GATHERING MOLTEN METAL; BLOWING; FORMING ELECTRIC LAMP BULBS.—E. Lecoultre (*Pat. J.*, No. 1625, 1920). Pat. No. 137,544, Jan. 9, 1920. Relates to a multiple head rotary automatic machine for blowing electric-lamp bulbs. A number of blowpipes are mounted on arms which rotate about a central shaft. As each blowpipe makes one complete rotation round the machine, the blowpipe is dipped into a tank to gather the glass, it is raised and the gather is marvered, it is lowered and swung to elongate the gather, the parison so formed is blown into a mould, the pip of the blown bulb is drawn out for the attachment of the evacuating tube, the bulb is severed from the tube, and the moil is removed from the end of the blowpipe.

GLASS MANUFACTURE.—M. Mathy (*Pat. J.*, No. 1626, 1920). Pat. No. 137,660, Feb. 27, 1919. Relates to apparatus for remelting the sharp edges of glass articles left by cutting.

GLASS MANUFACTURE.—Empire Machine Co. and B. D. Chamberlin (*Pat. J.*, No. 1631, 1920). Pat. No. 138,895, Feb. 9, 1920. Relates to the delivery of uniform charges of molten glass from tank furnaces. The object of the invention is to prevent or to minimise the chilling or scarring of the charge by the shearing-mechanism.

GLASS FURNACES.—Soc. C. Boucher et Fils (*Pat. J.*, No. 1631, 1920). Pat. No. 138,933, Feb. 12, 1920. In a gas-fired tank furnace for melting glass, the furnace proper and the gas producer are built respectively above and below the ground level, and the air supply for combustion is heated in passages beneath the tank, in the double roof, and in proximity to the producer and its associated flue.

GLASS-BLOWING.—J. Macluskie (*Pat. J.*, 1632, 1920). Pat. No. 139,322, March 24, 1919. Relates to a mould for blowing bent-necked bottles.

CASTING POTS FOR OPTICAL GLASS.—A. B. Taylor (*J. Soc. Glass Tech.*, **4**, 140, 1920). Relates to the casting of pots for use in experimental work. The pot mixture consisted of china clay and grog (fired to cone 18) in the proportion 3:2. The grog was previously passed through a sieve of 20 (in some cases 30) meshes to the inch. One-eighth per cent. of the total dry weight of sodium carbonate, and one-eighth per cent. by weight of the clay content of sodium silicate, were added in solution, making together about 0·2 per cent. of the total dry weight. Reproduced photographs show sections of cast pots in which the distribution of clay and grog is well seen. Pots were cast with and without application of pressure to the slip.

DENSITY OF SODA-MAGNESIA GLASSES.—S. English and W. E. S. Turner (*J. Soc. Glass Tech.*, **4**, 153, 1920). The density varies according to the condition of strain, as in the case of many metals, and in glass and metal alike re-annealing results in an increase in density.

DISCOLORATION PRODUCED BY LEAD, ANTIMONY, AND ARSENIC IN LAMPWORKED GLASS TUBING.—F. W. Hodkin and W. E. S. Turner (*J. Soc. Glass Tech.*, **4**, 158, 1920). Results of experiments showed that both arsenious and antimony oxides are very potent in causing discoloration when the glass is worked in a flame, far more so than lead oxide. The minimum amount of arsenious and antimony oxides required to be present in the glass to yield discoloration lies between 2 and 5 parts in 10,000. For lead oxide, 60 parts in 10,000 would be the minimum. The results are apparently independent of the presence of nitre, and the presence of sufficient manganese dioxide to act as a decoloriser, does not hinder discoloration.

DEVELOPMENT OF OPTICAL GLASS DURING THE WAR.—C. J. Peddle (*J. Soc. Glass Tech.*, **4**, 225, 1920). An introductory statement preceding the series of papers by the same author on the development of various types of glass (same volume, pp. 3, 20, 46, 59, 71). The statement is followed by a discussion on the papers.

A NEW TYPE OF GAS-FIRED FURNACE.—M. W. Travers (*J. Soc. Glass Tech.*, **4**, 205, 1920). Relates to a furnace used in a glass works. It is known as the Dennis Simplex Furnace, and was derived from a pre-existing gas-fired furnace of a Continental pattern, with two producers built into the centre of it, and flanked by recuperators. The gas from the producers rose through a central eye, meeting the hot secondary air from the recuperators at a little distance below the siege. The eight pots stood in a circle about the eye, and the products of combustion passed between the pots, through openings in the pillars supporting the crown, and thence downwards into flues leading to the recuperators. Very intense combustion took place in the eye and behind the pots, and for this and other reasons this furnace was not satisfactory. Finally, one of the flues collapsed, one of the recuperators became full of glass, and the furnace was put out of action. As an emergency measure, the furnace was reconstructed, the producers being removed and replaced by a Frisbie under-feed grate. The altered furnace was found to work very efficiently, and was extremely easy to handle. Above the grate (45 inches square) is a conical space tapering upwards to the eye (33 inches in diameter), the grate bars being 6 ft. below the siege. The products of distillation from the fresh fuel pass through a red-hot layer, the tarry matter and heavy hydrocarbons being largely decomposed. The partly carbonised fuel is pushed outwards over the grate bars, and the coke is gasified by the air passing through it. The depth of the fuel bed is 6 to 9 inches, but gasification of the fuel is sufficiently complete. The secondary air enters laterally about 30 inches below the eye, but combustion does not take place below the siege, and practically no clinker is formed on or about the grate. After cleaning the grate and firing up, but at no other times, a little smoke escapes from the stack. The weekly consumption of fuel during nine months rarely exceeds $9\frac{1}{4}$ tons, and it is estimated that 11 cwt. of molten glass (out of 14 cwt.) could be worked out of each pot, the colour and quality of the glass being excellent. The actual output—much below the full capacity—was found to be over 1 ton of glass per ton of fuel. After nine months working, the eye of the furnace was not appreciably enlarged, and there was no trouble through pots splitting down the back.

SULPHATE-WATERGLASS MIXTURES AS SUBSTITUTES FOR ALKALIS IN GLASS BATCH.—L. Springer (*Sprech.*, **53**, 21, 1920). A short article indicating the method of calculating the amount of sulphate-waterglass mixture required to replace a given quantity of sodium sulphate in batches.

VI—CEMENT, CONCRETE, MORTARS, ETC.

CONCRETES AND MORTARS.—F. L. Smidth & Co. (*Pat. J.*, No. 1625, 1920). Pat. No. 137,534, Jan. 8, 1920. "Moler", silicious earth, diatomaceous and infusorial earth, etc., is burned and ground, and added to Portland cement to produce a mortar. By the employment of burned material, larger quantities—up to 50 per cent. by weight of the whole—may be added to the cement.

STANDARDISATION OF CONCRETE STONEWORK FOR BALUSTRADES.—A. Friesecke (*Tonind. Ztg.*, **43**, 576, 1919). Standardisation is essential to improve the quality and durability of the finished product. Certain types of balustrades are illustrated.

CONCRETE KERB-STONES.—Anon. (*Tonind. Ztg.*, **43**, 554, 1919). A discussion of the possibilities of substituting concrete for natural stone in districts where the latter is not readily obtainable.

FERRO-CONCRETE SHIPBUILDING.—Anon. (*Tonind. Ztg.*, **43**, 475—6, 1919). Taken from a paper by Dr. K. Commentz, who discusses the properties of ferro-concrete from the shipbuilders' point of view, together with the technical and economic details connected with the use of this material for shipbuilding.

CEMENT ROOFING TILES.—Kroher (*Tonind. Ztg.*, **43**, 443—4, 1919) A retrospective review of the progress made in the manufacture of cement tiles since they were first introduced 75 years ago.

CONCRETE PARK BENCHES.—Anon. (*Tonind. Ztg.*, **43**, 397, 1919). Three types of benches are illustrated, the feet of which are formed so as to fit into concrete foundations. The bench is thus not easily moved and is less likely to be damaged.

CONCRETE BLOCKS AS SUBSTITUTES FOR BRICKS.—E. Tucker (*Tonind. Ztg.*, **43**, 427—8, 1919). Though the ordinary brick cannot be improved upon as building material for dwelling houses, the conditions in Germany make it necessary to look for some suitable temporary substitute. The article describes (with illustrations) several methods of building with hollow concrete blocks.

ASBESTOS-CEMENT SLABS.—W. Schmidt (*Tonind. Ztg.*, **43**, 378, 389—90, 1919). A short, general description of the Hatschek method of making asbestos-cement slabs.

ARTIFICIAL STONE SLABS FOR RAILWAY CROSSINGS.—(*Tonind. Ztg.*, **43**, 372, 1919). A short description of a method of laying railway crossings with slabs of artificial granite.

A DANISH MACHINE FOR MAKING CEMENT TILES.—(*Tonind. Ztg.*, **43**, 333—4, 1919). A short description, with illustration.

WATERPROOF CEMENT TILES.—(*Tonind. Ztg.*, **43**, 312, 1919). To make waterproof cement tiles, correct granular composition of the sand, and proper mixing with the binding medium are essential. The usual mixture of 3 parts sand with 1 of cement does not produce a thoroughly waterproof body. The surface has to be rendered more dense by beating. For cement tiles the mortar must be quite moist, so that little pressure is needed to render it dense.

ECONOMICAL BUILDING MATERIALS.—Neumann (*Tonind. Ztg.*, **43**, 299—300, 1919). The writer strikes a warning note with reference to the practical utility of most of the novelties exhibited at the Berlin Exhibition.

THE FIRE-RESISTING PROPERTY OF LIMESTONE CONCRETE. (*Tonind. Ztg.*, **43**, 301, 1919). At higher temperatures, CO_2 is given off and consequently much heat is absorbed. CO_2 itself is also a bad conductor of heat, and so helps to check the progress of fire.

FIRE-PROOF COATINGS OF PLASTER OF PARIS.—(*Tonind. Ztg.*, **43**, 258—9, 1919). As a protection against fire, all iron and wooden supports of a building may be covered with a coating of plaster 2 cm. thick. The plaster, attached to a tissue, is supplied in rolls 1·50 m. long and 0·67m. wide.

NEW MORTAR-MIXING MACHINES.—(*Tonind. Ztg.*, **43**, 272—3, 1919). A description (illustrated) of some mixing machines, in which the hoisting apparatus, for bringing the mixture into the mixing trough, is eliminated. Much motive power is thus saved. The mixture is brought to the machine in trolleys, which pass underneath the mixer, so that the body of the trolley constitutes the mixing trough of the machine during mixing.

MIXING CEMENT POWDER WITH COKE SLACK.—H. Roder (*Tonind. Ztg.*, **43**, 197—8, 1919). A short description of a machine, patented by a Hamburg firm, for mixing the powder, coke and water in the required quantities.

MANUFACTURE OF CEMENT ROOFING TILES.—(*Tonind. Ztg.*, **34**, 225—7, 1919). For districts where clay is scarce but sand plentiful, the cement tile should prove a useful building material. The article describes a machine for making these tiles in various forms.

HOLLOW BLOCK BRICKS.—F. Erdmenger (*Tonind. Ztg.*, **43**, 227, 1919). An article pointing out the numerous advantages of using a hollow block brick, 4 times the size of a standard brick but only 2½ times its weight for building purposes.

LEVEL CROSSINGS COVERED WITH CONCRETE.—(*Tonind. Ztg.*, **43**, 180—1, 1919). A short description of methods at present in use in America for covering level crossings with concrete slabs instead of wood.

CEMENT FLUSHING CISTERNS.—(*Tonind. Ztg.*, **43**, 181, 1919). A Munich firm successfully manufactures lavatory flushing cisterns out of cement. An iron case, usually a sort of wire gauze, is necessary in all cases. Only the best raw materials can be used, and most careful workmanship is essential to the production of a thoroughly water-tight product.

THE RUSTING OF IRON IN FERRO-CONCRETE.—H. Luftschitz (*Tonind. Ztg.*, **43**, 171—2, 1919). The writer maintains that the chemical reactions taking place in the concrete do not constitute the main factor in preventing or hindering the formation of ferric hydroxide (rust). The iron is only prevented from rusting by the fact that it is surrounded by a more or less air-tight coating.

SPRAYING PROCESS FOR CONCRETE AND MORTAR.—(*Tonind. Ztg.*, **43**, 141, 1919). The advantages of this process for extensive repair work is emphasized, and an instance cited of a 50 m. chimney being satisfactorily renovated within 12 days. The process might also be extended to the construction of concrete ships.

COMPRESSED AIR FOR CEMENT GOODS.—(*Tonind. Ztg.*, **43**, 164, 1919). Considerable economy might be effected by substituting compressed air power for hand labour in stamping processes, etc.

CEMENT ROLLERS FOR FIELD WORK.—(*Tonind. Ztg.*, **43**, 91, 1919). Cement rollers weighing from 500 to 1000 kg. and from 1·50 to 1·70 m. in length have proved successful. After 6 months they may safely be drawn over rough roads without fear of damage.

ROUGH AND FACE BRICKS VERSUS PLASTERING FOR BUILDING PURPOSES.—G. Hanel (*Tonind. Ztg.*, **43**, 82—3, 1919). Polemical.

THE SIZE OF HOLLOW CONCRETE BLOCKS.—(*Tonind. Ztg.*, **43**, 83—4, 1919). For small two-storied houses, the smaller 9-brick blocks made on the spot, are recommended, while for general purposes the 12 or 16 brick blocks are the more economical.

RE-INFORCED-CONCRETE SHIPS.—(*Tonind. Ztg.*, **43**, 70—1, 1919). A short article dealing with the main points, more particularly in connection with the construction of river craft.

SAND-LIME BRICKS, A CHEAP BUILDING MATERIAL.—(*Tonind. Ztg.*, **43**, 69—70, 1919). An outer wall built of sand-lime bricks, with an inner lining of hollow blocks, is said to give a durable structure at low expense. The inner lining, which has good insulating properties, and will support nails satisfactorily, is made in blocks by the Hamblock process out of pumice stone, Rhenish trass, hydrate of lime, and tufaceous ash.

COAL AND CONCRETE.—W. Petry (*Tonind. Ztg.*, **43**, 56—7, 1919). The writer is of the opinion that the importance attached to the deteriorating

effect of coal on concrete has been greatly exaggerated. A concrete floor upon which all kinds of coal had been stored in the open for over 8 years, showed no perceptible signs of deterioration. The possible effects of sulphur in the coal might be guarded against by applying a layer of Keene's cement to the concrete.

FIRE TESTS ON REINFORCED CONCRETE.—(*Tonind. Ztg.*, **43**, 32—3, 1919). A short account of experiments carried out in 1913 on two two-storied houses.

GRIPPING POWER OF CEMENT.—H. Luftschitz (*Tonind. Ztg.*, **43**, 7—8, 1919). A recapitulation of the views already expressed by the writer in previous papers.

PLASTER FOR VENTILATING-SHAFTS.—R. Rüdinger (*Tonind. Ztg.*, **40**, 726, 1916). Plaster, not lime, should be used for the inside of ventilation shafts or pipes in large rooms, as the smooth surface of plaster offers less resistance to the air, and is easier to clean. This economises space, as a shaft of smaller diameter can be used. P.W.T.

GOOD PORTLAND CEMENT.—K. Reinbold (*Tonind. Ztg.*, **40**, 552, 1916). Notes referring to the refutation of certain views of Spindel's by T. Peruis. Report by the latter is printed in the "Zeitschrift des Österreichischen Ingenieurvereins, No. 13, p. 249". P.W.T.

FERRO-CONCRETE INSTEAD OF GRANITE.—T. Conring (*Tonind. Ztg.*, **40**, 694, 1916). Relatively small surfaces destined to support the arches of railway bridges are often constructed with granite which is, in itself, a satisfactory material for the purpose, but the difficulty in mortaring may lead to unevenness, causing the upper blocks of granite to crack—a costly matter to repair. Ferro-concrete is frequently used for the above-named purpose, and gives good results. A short description of the method is given. P.W.T.

CHAMOTTE MORTARS.—F. Boehring (*Tonind. Ztg.*, **40**, 679, 1916). Advises users of this kind of mortar to benefit by the experience of the makers, to leave the choice to the latter, and to let them say for which portions of the construction it is to be used. One would thus be sure of obtaining a sufficiently refractory mortar and one which hardens enough in the thicker parts of the construction not exposed to the fire or to great heat. P.W.T.

CEMENT IN WATER CONTAINING SULPHURIC ACID.—Dr. W. Roeder (*Tonind. Ztg.*, **40**, 664, 1916). Results of experiments with various cements are given in the July number of "Armierter Beton." They confirm the opinion of Dr. Passow, that blast furnace cements appear to withstand water containing acid better than Portland cement. Two Portland cements, 1 iron Portland cement, 5 slag cements and one mixed cement of $\frac{2}{3}$ Portland and $\frac{1}{3}$ slag cement, were tried. All were trade cements, and stood the standard tests. The trials consisted of cement and 1 to 2·5 sand; hardened 48 hours in moist air, then six days in water, 14 days in the air of a room, and finally 14 days in pipe-conveyed water. They were then placed in an acid bath containing 1% sulphuric acid. After 14 days, the H_2SO_4 content was 1.2%, and after 14 days, the bath was renewed and brought up to 1·5%, in which the trials remained for 3 months. Those bodies which stood the test with but little or without any damage, were exposed to the air for 6 weeks and again placed in a bath containing 1·5% sulphuric acid.

The Portland cement, which was most resistant under the standard tests, showed after two weeks considerable gypsum separation. All the cements were attacked, but decomposition was very small in the furnace slag cements. The latter were characterized by the formation of a protective layer which evidently prevented the liquid from penetrating into the body of the trial. This layer was clearly of a different colour from that of the interior of the trial. After four months, the shape of the slag cement remained good, whilst all the others showed considerable decomposition after a short time. P.W.T.

PLASTER FLOORS.—M. Neuhaus (*Tonind. Ztg.*, **40**, 670, 1916). A short article in favour of plaster floors. These must be allowed to dry properly. Linoleum, for example, is frequently laid down too soon, evaporation causing it to warp. Blotting paper covered with dry boards will indicate when the floor is quite dry. P.W.T.

PLASTER FLOORS FOR GRANARIES.—B. Bosz (*Tonind. Ztg.*, **40**, 694, 1916). For storing grain at farms, plaster floors are better than cement floors. The advantages are:—gradual evaporation of any moisture absorbed, cleanliness, freedom from insects and vermin. P.W.T.

WHEN IS CONCRETE DRY?—R. Fabian (*Tonind. Ztg.*, **40**, 862, 1916). On the drying of concrete intended to receive a coating of paint, tar, asphalt, etc. The process of drying is described. The dryness of concrete is usually judged from the colour of the surface, this being no proof of the dryness of the inner portion. The following simple method of ascertaining the dryness is given:—On one or more parts of a floor, a few sheets of ordinary dry blotting-paper, folded double, are placed flat, and over each a sheet of asphalt-paper (asphalt side downwards), and both covered with pieces of board. If, the next morning, the cement still contains a considerable amount of water, the blotting paper will be moist. If only a trace of moisture be detected, the floor may be considered to be dry. This method (altered as the case may be), can be applied to walls or ceilings. P.W.T.

RINGS FOR WELLS.—R. Fabian (*Tonind. Ztg.*, **40**, 675, 1916). On the use and advantages of concrete and ferro-concrete rings for well sinking. P.W.T.

CEMENT BLACK.—(*Tonind. Ztg.*, **40**, 717, 1916). One per cent. of cement black "A" made by the Wagelin Co., colours as strongly as 3% manganese black. P.W.T.

REFRACTORY MORTAR.—E. Trab (*Tonind. Ztg.*, **40**, 709, 1916). Writer refers to article by F. Boehring, *Tonind. Ztg.*, **40**, 679, 1916, and agrees with him. He understands Boehring to mean that mortar not exposed to the fire is hardened by the addition of clay to the chamotte. Reference is made to the sintering and melting of certain kinds of mortar and to a patent mortar (D R P, 263, 703) consisting of 100 parts calcined quartz, 10 soda, 10 dextrine and 15 iron ore, but the writer does not know whether this patent has proved successful. Rock salt promotes sintering of refractory mortars, such as those used chiefly for coke-ovens. P.W.T.

VII.—CHEMICAL AND ANALYTICAL PROCESSES.

COLORIMETRIC TESTS FOR MINERALS AND ROCKS WITH ORGANIC AND INORGANIC COLOURING MEDIA.—W. Zwieg (*Sprech.*, **53**, 169, 1920). A general review of the methods hitherto employed for the identification of mineral matter.

THE ANALYSIS OF SILICATE AND CARBONATE ROCKS.—W. F. Hillebrand (*U.S. Geol. Survey, Bulletin* 700, 1919). A revised and enlarged edition of Bulletin 422, with sections on special methods applicable to silicate rocks, quality of apparatus, reagents, etc., carbonate rock analysis, and refined methods of analysis.

TESTING SWEDISH BRICKS.—Son Schlyter (*Tonind. Ztg.*, **43**, 172—3, 1919). Taken from Bulletin 61 of the Bureau for Testing Materials of the Stockholm Technical High School. The results of tests carried out on various types of bricks, face-bricks, sand-lime bricks, between 1911 and 1916 are published, together with numerous tables, illustrations and graphs.

MEASUREMENT OF INTERNAL FORCES BY OPTICAL METHODS.—H. Schulz (*Sprech.*, **53**, 3—4, 1920). A short review of the subject.

COLLOIDAL CHEMISTRY AND A "COLLOID MILL."—(*Engineering*, **60**, 429, 1920). A somewhat lengthy discussion of the rather remarkable claims made by Hermann Plauson on behalf of a new type of fine grinding disintegrator or "colloid" mill. This is said to be the ideal apparatus for the extremely fine grinding required for homogenising and dissolving substances and for obtaining emulsions and colloidal preparations. It is claimed to be particularly valuable for the industries associated with the manufacture of Fullers earth, colloidal coal, plastic substances, soaps, etc. Methods for the preparation of colloids may be classified as follows: (1) *Dispersion Methods*—(*a*) organic disperse media, (*b*) kathodic disintegration, and (*c*) heat energy; (2) *Condensation Methods*—(*a*) chemical reactions, *e.g.*, reduction by metallic salt solutions, (*b*) electrochemical reactions, (*c*) photochemical reactions, (*d*) molecular polymerisation.

In 1911, Plauson began experiments to determine the optimum conditions for obtaining by mechanical means a disperse stage much higher than hitherto attained. The substances used were coal, talc, graphite, etc. The results were: with the usual types of grinding mills the fineness obtained in dry grinding was 0·01 to 0·008 mm.; in very exceptional cases the fineness was 0·001 to 0·008 mm. With wet grinding the results were a little better. In 1912, he designed a modification of the ordinary druggists "Perplex" beater mill and fitted the shaft with a stuffing-box in order to make the mill water-tight. By running such a mill at very high speed, Plauson claims to have achieved the fineness of a colloidal solution, exceeding 0.0001 mm. He further discovered that different disperse media gave different results, and that the addition of certain substances improved the fineness. In the grinding of coal, for instance, greater fineness in less time was obtained when an alkaline solution of glue and certain albuminoids—lysalbic acid and its salts—were added to the medium as accelerator or protective colloid. Inhibitive substances, such as acids and electrolytes must be removed from the disperse medium by washing or extraction, or a higher proportion of protective colloid must be added. The proportion of water or other disperse medium is important; as a general rule, the higher the proportion the better, and the greater the viscosity of the medium the higher the proportion of dispersoid. In grinding coal in water, 10 parts of the former would be used with 90 parts of water, but if oil is used, the proportion of coal can be increased to 40 or 45%. The grinding is continued until the surface tension is greater than the force of gravity, or until the particles no longer settle. If a mixture containing a high percentage of disperse coal in oil has a further quantity of oil added to it, the Brownian movement of the coal particles can easily be observed under the microscope. Most substances with sufficient dilution can be made to exhibit all the properties of a colloidal solution. Briefly, the process is as follows: 30 parts of the substance are treated with 70 parts of the disperse medium in a suitable apparatus, diluted with further quantities of medium, and left to stand in a columnar vessel for ¼ to 12 hours. The liquid is then drawn off, further quantities of disperse medium are added to the lower part, znd the mixture again passed into the beater-mill. The drawn off liquid is perfectly homogeneous and has the characteristics of a colloidal solution. The new machine is called thv colloid mill (Kolloidmühle) and is manufactured by the Maschinenfabrik Emil Passburg of Berlin. It has already been used successfully on a large scale in a Hamburg works for the manufacture of colloidal cellulose. It consists of one or two excentrically arranged discs or pistons carrying beaters of any desired form and revolving at a very high speed. Instead of the beater action of the ordinary disintegrator type, friction may be used. The article concludes with a discussion of the various commercial uses to which the machine may be put.

VIII.—HISTORICAL, EDUCATIONAL, INSTITUTIONS, ETC.

MY EXPERIENCES IN CERAMICS.—E. Heinecke (*Sprech.*, **53**, 203, 1920). The writer, who is Principal of the Royal Ceramic Institute in Bunzlau, describes his experiences since the foundation of the institution in 1897.

THE GERMAN CERAMIC SOCIETY.—(*Sprech.*, **53**, 353, 1920). The former technical department of the Manufacturers' Association in the German ceramic industry has been reorganised and extended, and now carries on its wider activities under the name of "The German Ceramic Society." The results of work carried out under the direction of the Society will be published in the Society's own reports, the first number of which has already appeared.

THE MANUFACTURE OF REFRACTORY MATERIAL IN TURKEY DURING THE WAR.—G. Bergau (*Tonind. Ztg.*, **43**, 712—3, 722—3, 1919). An account of the experiences of a German engineer, who worked up the manufacture of grog and silica bricks in Asiatic Turkey after the supply of war material through Roumania was cut off. His experience with quartzite, found after long search in the vicinity, convinced the writer of the necessity of examining this material under the polarising microscope before using it in the manufacture of bricks.

INTRODUCTION TO CERAMICS.—A. Berge (*Sprech.*, **53**, 73, 1920). A summary of seven lectures delivered by Dr. Berge at the Bunzlau High School, Silesia.

STUDIES IN OLD SILESIAN ART-POTTERY.—K. Strauss (*Sprech.*, **53**, 192, 1920). A short illustrated sketch.

THE CLAY AND KAOLIN WORKS OF SAXONY DURING THE YEARS 1915, 1916 AND 1917.—(*Tonind. Ztg.*, **43**, 533, 1919). Taken from the Year Book for Mining and Metallurgy in Saxony for the years 1916/18, with statistics from 1915 to 1917.

NOTEWORTHY BUILDINGS IN EAST AND WEST PRUSSIA.—C. Sickel (*Tonind. Ztg.*, **40**, 679, 685, 689, 674, 699, 1916). A series of articles on the history and architecture of old buildings in E. and W. Prussia. P.W.T.

CERAMIC ART IN SYRIA AND MESOPOTAMIA.—G. Badermann (*Tonind. Ztg.*, **40**, 483, 496, 506, 1916). General notes on ceramic products (old and recent). P.W.T.

EDIFICES FOR CEMETERIES.—G. Friese (*Tonind. Ztg.*, **40**, 867, 1916). a description of ceramic building materials and of two buildings in the St. Pauli Cemetery, Dresden (with two illustrations). P.W.T.

CERAMICS FOR CEMETERIES, TOMBSTONES, ETC.—J. Lerg (*Tonind. Ztg.*, **40**, 517, 1916). An account of some work by Herborth, of Strasbourg. P.W.T.

LÄUGER WARE.—J. Lerg (*Tonind. Ztg.*, **40**, 715, 1916). An account of Max Läuger's productions. (Illustrated). P.W.T.

PECULIAR PHENOMENON.—G. Neuhaus (*Tonind. Ztg.*, **40**, 59[illegible], 1916). Gives two cases of workmen who were suffering from far-advanced pulmonary disease being greatly relieved by working in lime dust. P.W.T.

PECULIAR PHENOMENON.—K. Bernhard (*Tonind. Ztg.*, **40**, 676, 1916). The writer accepts unreservedly the opinion of Neuhaus, and gives references of articles in medical journals in confirmation of the view that lung diseases are cured by working where there is plenty of lime dust. P.W.T.

PHTHISIS IN LIME WORKS.—G. Hall (*Tonind. Ztg.*, **40**, 703, 1916). The writer gives cases he has met with of the beneficial effect of lime dust on consumptives, and mentions a works where all kinds of dust-preventing contrivances were of no avail, and another works at which the authorities sanctioned work being carried on without protection against dust, on the evidence of ten years records which showed an extraordinary immunity from lung diseases amongst the workmen. P.W.T.

CLAY AS A REMEDY.—H. Jacer (*Tonind. Ztg.*, **40**, 478, 1916). Notes on the revival of the use of clay for medicinal purposes. It has been used successfully in the treatment of cholera, digestive organs, inflammation of the throat, diptheria, wounds, cleaning of teeth, etc. Finely powdered clay absorbs bacteria and prevents their entry into the blood. P.W.T.

Abstracts.

1.—RAW MATERIALS: GENERAL.

NATURAL SANDSTONE AS REFRACTORY MATERIAL.—E. S. (*Sprech.*, **53**, 456, 1920). The purer varieties of sandstone are the best refractory material known. When freshly quarried, sandstone usually contains much water. It should first be converted into bricks of the size required, and then left to dry in a moderately warm atmosphere. Drying should be completed in a well-heated place. A period of from 6 to 8 months for drying gives the best results. To allow for expansion in the furnace, joints should be made corresponding to a width of 6 to 8 cm. per metre of surface. The tempering of a new furnace must be carried out very carefully; the temperature must be allowed to rise very gradually.

REFRACTORY MATERIALS USED IN THE CHEMICAL INDUSTRY.—R. Kien (*Cer.*, **22**, 147, 1919). A short account under the headings: (1) clay, (2) silica, (3) alumina, (4) magnesia and lime, (5) metallic oxides and various.

KIESELGUHR.—Leisteres (*Tonind. Ztg.*, **44**, 1125, 1920). A short account of the properties and uses of diatomaceous earth, sometimes incorrectly termed infusorial earth. (See TRANS. **19**, Abs. 111, 1920).

CERAMIC RAW MATERIALS IN FRANCE.—(*Tonind. Ztg.*, **44**, 1329, 1920). Taken from a report published in "Ciment." Abundant supplies of good clays are found widely distributed throughout France, with the exception of a reliable white-firing variety for fine earthenware. The French earthenware tile industry is still dependent upon the Westerwald clays. Cornwall supplies almost one half of the china clay used in France. With regard to refractory clays, France has rendered herself independent of foreign supplies.

GERMAN RAW MATERIALS.—(*Ber. D. K. Ges.* **1**, No. 1, 40, 1920). The problem of substituting German for hitherto imported raw materials is now receiving the attention of the Techno-Chemical Department of the State Porcelain Factory at Charlottenburg, with the co-operation of the German Ceramic Society.

THE RARE EARTHS; THEIR NATURE AND USES.—H. Sachse (*Tonind. Ztg.*, **44**, 1096, 1920). Rare earths is the name given to a group of basic oxides, the cerite earths, with the elements thorium, lanthanum, cerium, praseodymium, neodymium, samarium, europium, and the gadolinite or yttrium earths, with the elements scandium, yttrium, gadolinium, terbium, dysprosium, holmium, erbium and thulium. In a wider sense, the oxides of a number of other rare elements may be included, viz.: zirconium, titanium, vanadium, niobium, tantalum, molybdenum, lithium, rubidium, caesium, beryllium, cadmium, gallium, indium, thallium, and occasionally even selenium, tellurium, tungsten, uranium, radium, mesothorium, thorium, radiothorium, and others.

For the manufacture of gas mantles, a strong solution of a mixture of 99% of thorium nitrate and 1% cerium nitrate is used. Upon burning, the fibre of the mantle is destroyed and the oxides of thorium and cerium remain. The raw material is obtained from the monazite sands of Brazil and the East Indies. These, however, contain little thorium (about 1%); the main constituents are phosphoric acid and the cerite earths, a mixture of about 45% cerium oxide, 25% lanthanum oxide, 15% neodymium oxide, 7% praseodymium oxide, with some samarium and yttrium oxide. The commercial utilisation of this material was made possible by the discovery of pyrophoric metals by Auer von Welsbach. The cerite metals, obtained electrolytically, are mixed with heavy metals to produce a sparking medium for lighting gases and liquids.

Cerite earths are also used as mordants in the dyeing industry, for reducing

the density of negatives and as flash-light powder in photography. Cerium salts may further be applied as oxidising agents for organic compounds and as catalysts. The phosphates of didymium, or of its constituents—neodymium and praseodymium, have been recommended for colouring porcelain. Didymium is also used in the glass industry. Selenium is made use of in telegraphic photography, whilst selenium and tellurium salts have recently been introduced into photography and medicine.

CERAMIC AND PAPER KAOLIN.—H. E. (*Tonind. Ztg.*, **44**, 439, 1920). The writer disputes the statement that the deposits of Czecho-Slovakia contain kaolins of the finest qualities, both for ceramic purposes and also for paper manufacture. They are in no way superior to the best German varieties.

CARBONATE OF LIME.—(*Tonind. Ztg.*, **44**, 529, 1920). A short article on the properties of carbonate of lime as a manure.

KAOLIN.—Anon. (*Tonind. Ztg.*, **43**, 1175, 1919). A short article dealing with general properties and uses.

BAVARIAN TRASS.—W. Sieber (*Tonind. Ztg.*, **43**, 1213, 1919). A reply to E. Gebauer. (See page 4).

ELECTRIC FURNACE REFRACTORIES.—A. F. Greaves-Walker (*Chem. Met. Eng.*, **23**, 933, 1920). A paper read at the Columbus meeting of the Electric Furnace Association in October, giving a brief description of the raw materials now available for high-grade refractory bricks, together with a list of refractories recommended for melting the different metals and alloys. For electric furnaces, the following refractory materials are available: (1) *Basic*—magnesite, dolomite, zirkite, alundum or carborundum, bauxite; (2) *Neutral*—chromite, zircon, carbon, fireclay; (3) *Acid*—silica. Magnesite occurs naturally both in an amorphous and in a crystalline state, but the former is entirely unsuitable for refractory purposes. The Austrian ore is considered best. None of the neutral refractories have come into wide use in electric furnace work. Chromite ($FeO. Cr_2O_3$) is the best known. The following linings are recommended for various products. For steel ingots and castings—magnesite, when high-grade steels are required, and silica when there are no special requirements; for alloy steels—magnesite exclusively; for ferro-manganese—magnesite or carbon; for ferro-chrome—magnesite or chrome; for ferrosilicon—silica; for cast iron—fireclay bricks are used for low temperatures and when cupola practice is simulated, whilst silica is employed for high temperatures and rapid melting. Magnesite is used for irons of special low sulphur and phosphorus requirements. For the non-ferrous metals and alloys, magnesite is generally preferable, but for bronze and silver, silica should be used.

All refractories are injured by exposure to the weather; freezing is particularly harmful.

RAW MATERIALS: OCCURRENCE, PREPARATION, ETC.

CLAYS FOR TILES.—(*Tonind. Ztg.*, **44**, 1177, 1920). A report from the chemical laboratory for the ceramic industry. The quality of the clay depends mainly upon the following 3 properties: absence of useless impurities, clearness of the fired colour, and vitrescibility; the vitrification point should not be in the vicinity of the softening and melting point. The clay fires a white, grey, or yellowish-brown colour, sinters at cone 1a to 6, contains no calcium carbonate, gypsum or pyrites as impurities, and is at least moderately refractory. To obtain thoroughly vitrified ware, the body must be as uniform as possible. The "Osmo" (Westerwald) clay (*q.v.*), is recommended as specially suitable.

"OSMO" CLAY (WESTERWALD).—(*Tonind. Ztg.*, **44**, 650, 1920). The clay is washed and prepared by an electric process, and its composition is claimed to be constant. Its chemical composition is as follows: Silica

49·68%, alumina 34·40%, iron oxide 0·96%, calcium oxide 0·18%, oxide of potassium 3·52%, oxide of sodium 0·55%, loss on ignition 10·80%. Rational analysis gives: quartz 7·5%, felspar 1·2%, clay substance 91·3%. A remarkable feature in the analysis is the high alkali and low felspar content. The alkalies appear to be combined in an unusual manner, and this perhaps explains the good sintering quality and stability of the clay.

PREPARATION OF ZIRCONIA.—(*Chem. Trade J.*, **68**, 1745, 1921). A paper read by E. C. Rossiter and P. H. Sanders at a meeting of the Birmingham section of the Society of Chemical Industry. One of the chief difficulties in the preparation of zirconia was the complete separation from iron and alumina. The ore used in this investigation came from Brazil. It was ground fine in a porcelain ball mill before being used. During the grinding, it was found that about one half was much softer than the remainder, and this was separated. The object being the commercial preparation of zirconia, it was important that a comparatively ready method of decomposition be used, rather than aim at complete decomposition. Fusion of the ore, previously ground to the fineness of flour, with its own weight of caustic soda at a final temp. of about 600°C. yielded a product which, after extraction with hot water, was soluble in HCl to the extent of 80% of the ore. Fusion of the ore with 4 times its weight of nitre cake yielded a product which, on extraction with water, gave a solution containing 50% of the ore. As it was necessary to obtain the zirconia in solution as oxychloride in order to separate it completely from the iron and alumina, the fusion with caustic soda was preferred. Fifty grammes of the zirconia ore were mixed with equal weight of caustic soda and fused in an iron crucible; foaming took place and the mixture was continually stirred until it was converted into a granular powder. The temp. was then raised to just visible redness. The product was filtered and washed free from alkali; the insoluble residue was treated with HCl and the mixture evaporated to dryness. The product was then extracted with hot water and filtered. The insoluble matter after ignition amounted to 19—20% of the ore used and contained 61·55% ZrO_2, 29·32% SiO_2, 1·10% Fe_2O_3, 1.80% Al_2O_3, 5·9% loss on ignition. The solution contained zirconium oxychloride, and iron, alumina, titanium, manganese, etc. For the precipitation of the zirconia, the solution of the chloride was diluted to $1\frac{1}{2}$ litres, treated with sulphurous acid, in slight excess over that required to reduce the iron salts, and heated to boiling. Normal H_2SO_4 was then gradually added in amount equal to that theoretically required to replace the chlorine in the oxychloride or until the mixture became thick; after a short time, the whole of the zirconia was deposited as basic sulphate. This precipitate was easy to filter and settled rapidly. To obtain zirconia from the basic sulphate it could either be dried and ignited, or suspended in water, treated with alkali, and the hydroxide washed, dried, or ignited. Zirconia is precipitated from the boiling solution of its oxychloride both by sulphuric acid alone and by sulphurous acid alone; but the precipitates are usually difficult to filter and wash.

Properties of Basic Zirconium Sulphate. When dried at room temp. or at 100°C., it has the appearance and colour of clear amber. It is then easily soluble in conc. H_2SO_4, slightly soluble in HCl, and completely decomposed by prolonged boiling with sodium carbonate or ammonia. The hydroxide prepared by suspending the undried basic sulphate in ammonia was readily soluble in HCl, and this solution, when concentrated in the water bath and allowed to crystallize, yielded the oxychloride $ZrOCl_2.8H_2O$, crystallising in slender needles.

Regarding the determination of zirconia in the presence of iron and alumina, it was stated that, using a solution of zirconium oxychloride of known strength, it was found that, in the presence of a slight excess of H_2SO_4, quantitative results were obtained, and that the effect of a large excess of acid could be neutralised by dilution, the quantitative precipitation of the zirconia depending more on the strength of the acid than on the actual amount present. A quantitative separation from large amounts of iron was found to be possible.

A solution of pure zirconium oxychloride, prepared from the Brazilian ore, was boiled with H_2SO_3 and precipitated by the addition of a measured quantity of *N*. H_2SO_4. The basic sulphate was then filtered off, washed with hot water, and converted to zirconia by ignition to a constant weight.

PROTOL.—Anon. (*Tonind. Ztg.*, **43**, 1142, 1919). Protol is glycerine obtained in fermentation processes. Pasteur discovered that minute quantities of glycerine were formed when sugar ferments. Connstein and Lüdecke found that the quantity of glycerine formed was greatly increased by adding sodium sulphite. In the laboratory, 1 kg. sugar dissolved in 10 litres of water, to which 400 grs. sulphite together with the requisite fermentation media, gave very satisfactory results. During the war, a company was founded in Germany to undertake the commercial development of the process, which was gradually improved until 100 parts of sugar gave 20 parts glycerine, 27 parts alcohol and 3 parts aldehyde. The protol works produced 1000 tons of glycerine per month, for which 70000 tons of sugar were required annually. In view of the fact that glycerine is a by-product of soap manufacture, it is at least doubtful whether the new process will prove economical under peace conditions.

NOTES ON SOME KAOLIN AND CLAY OCCURRENCES IN THE KOPPA TALUK.—P. S. Iyengar (*Records, Dept. Mines and Geology, Mysore State*, **15**, 118, 1916). During April, 1915, a short visit to localities in the Malnad, where there is a considerable spread of laterite over gneissic rocks, was made with the object of locating deposits of kaolin material. The short time at the author's disposal did not permit regular prospecting work. A few samples were collected from the surface outcrops and trial washings were done on the spot, whilst both samples of the decomposed gneissic and pegmatitic materials were collected and taken to Bangalore for experimental purposes. From one area alone (Kikri), it is estimated that about 20000 tons of good washed kaolin could be obtained. After levigation, the kaolin varies in colour in the different localities from yellowish cream to white and contains from 28 to about 60% kaolin. Much mica was found in many of the samples. A deposit of good alluvial clay, slightly yellowish in colour and fairly plastic, was located near Hariharpur. It is used for pottery purposes, and the author considers it good for tile manufacture. Further deposits of similar material were found in other localities. The horizontal occurrence of very dark clay at a considerable depth is of geological interest.

NOTES ON PROSPECTING FOR KAOLIN IN THE KOPPA TALUK.—B. Balaji Rao (*Records, Dept. Mines and Geology, Mysore State*, **15**, 138, 1916). A report of a more detailed examination in April, 1916, of the kaolin deposits visited by P. S. Iyengar the previous year (see above). The country consists of high ridges, covered with thick jungles, and low valleys. The rock of the area is a greyish coarse-grained biotite gneiss, in which the biotite is disposed more or less in regular layers. Thin, small, caught-up patches of hornblend schist and a few dolerite dykes are found here and there. In places, the gneiss is traversed by a number of pegmatite veins which are highly micaceous. It also contains large crystals of tourmaline and kyanite. The deposits of kaolin are all situated within easy reach of water supply. The lateritic soil covering above this kaolin varies in thickness from 2 to 30 ft. There are large outcrops of a finely-grained white aplitic or porphyritic gneiss and gneiss traversed by white pegmatite veins. The author is of opinion that, in the majority of cases, the kaolin, a product of the decomposition of felspar, occurs as small pockets or segregations due to the decomposition of an aplite. The proportion of undecomposed constituents is unusually high in some cases, thus reducing the percentage of kaolin obtained after two or three washings. The mica and quartz in other cases are so fine that it is very difficult to separate them by levigation.

A description is given of the various deposits and the excavations carried out. Two plans are added, indicating the position of the boreholes and trenches. The results are tabulated, and from these it would appear that the percentage of kaolin obtained after washing varied from 12 to 50%.

BOG IRON-ORE.—Anon (*Deut.Töp. Zieg.Ztg.*, **50**, 325, 1919). Bog iron-ore, found in swampy districts, consists of iron oxide mixed with sand, clay, earth and organic matter. A similar material is also present in many clays. If available in sufficient quantities, it may be used for metallurgical purposes, provided that it contains a good percentage of iron oxide and is not rich in impurities such as sulphur and phosphor. For ceramic purposes, however, these impurities do not constitute a serious drawback. The ore may be used for making glazes which have a slate-like appearance, such as are often applied to roofing tiles. These glazes consist mainly of iron oxide and silica. Bog iron-ore sometimes occurs naturally with these two components present in suitable proportions, so that, when ground, it can be used directly as a glaze. The following three analyses have recently been made:

	1	2	3
Iron oxide	72·31	35·86	50·15
Manganese oxide	0·17	0·09	—
Silica	16·65	53·49	25·42
Alumina	2·11	0·67	3·14
Phosphoric acid	0·02	0·47	0·22
Sulphur	0·07	0·10	0·22
Ignition loss	8·67	9·31	15·65

In material No. 2 (above), the proportion of iron-oxide to silica is approximately 4:6. This would fire between cones 3a and 10 to a satisfactory matt glaze. These glazes might also be adapted to face-bricks and terracotta work.

EXTRACTION OF POTASSIUM FROM FELSPAR.—(*Deut. Töp. Zieg. Ztg.*, **50**, 219, 1919). A short account of the Ashcroft process. Powdered felspar is heated with an equal quantity of NaCl to 900 or 1000°C. for about 2 hours, the reaction being: $2NaCl + K_2O.Al_2O_3\ (SiO)_6 = Na_2O.Al_2O_3(SiO_2)_6 + 2KCl$.

AMMONIUM SULPHATE FROM ROCK GYPSUM.—Anon. (*Tonind. Ztg.*, **43**, 1251, 1919). Ammonia and CO_2 are passed into a suspension of finely-ground gypsum, calcium carbonate being precipitated out whilst ammonium sulphate is held in solution. After filtering, the solution is boiled down in the usual way. The necessary CO_2 is available in the form of flue gas.

ZIRCONIUM SALTS.—H. Wade (*Pat. J.*, 1,669, 1921). No. 153,133, Aug. 8, 1919. A new basic sulphate of zirconium of the composition 5 ZrO_2, $3SO_3$, 13 H_2O free from iron, titanium and silicon is obtained by adding H_2SO_4 in the requisite quantity to a solution of zirconium oxychloride containing free acid, preferable HCl. The basic sulphate is precipitated on heating.

TREATING CLAY.—P. Schidrowitz, W. Feldenheimer and W. Plowman (*Pat. J.*, 1,670, 1921) No. 153,861, June 2, 1919. The clay is suspended in water with the aid of a deflocculator such as sodium carbonate, and then evaporated to dryness before any settlement takes place. It may first be mixed with sufficient water to give a pasty mass and then enough deflocculator added to produce fluidity, with or without further addition of deflocculator until the fluidity decreases; or the clay may be worked up directly with water and deflocculator.

ZIRCONIUM.—W. North, and H. Loosli (*Pat. J.*, 1,673, 1921). No. 155,299, Dec. 15, 1920. Zirconium ore or oxide is reduced by mixing it with the theoretical amount of carbon and heating the mixture under increased pressure in an electric furnace. The current may pass through the charge itself, or a conductive carbon core may be used.

EXCAVATING CLAY.—Weber & Co. (*Pat. J.*, 1,680 1921). No. 157,461, Jan. 10, 1921. Clay is excavated and conveyed away by means of a system of pipes. One or more jet-pipes, connected to a water supply, are adjustably mounted within larger pipes, through which the water passes away after excavating the clay.

ROCK DUST COLLECTING.—(*Rock Products*, **24**, No. 5, 19, 1921.) A well-illustrated description of a system developed by the Metro-Nite Co., Milwaukee, in the manufacture of pulverised dolomite filling for paints and enamels. It is well known that, in the preparation of stone to be used as a filling for mixed paints and enamels, the very fine particles of dust caught during the grinding of the stone to powder, is really the most valuable product. The rock used, which should be pure white and contain no foreign matter, is of a crystalline character and analyses as follows: calcium carbonate 44·62%, magnesium carbonate 35·65%, and calcium magnesium silicate 19·58%. It is therefore a siliceous dolomite. The material is first pulverised and passed through air separators, the latter including two cyclones. The fine particles pass from the first air separator proper to the first cyclone and the still lighter and finer to the second cyclone. By an arrangement of screw conveyors and bucket elevators the coarse material from the air separators is again passed through the first separator before being sent back to the tube mills for repulverization. The dust created in preparing so fine a material is collected and bagged by means of a 20-in. exhaust fan operating through a system of pipes placed at any suitable point. The fine dust (about 350 mesh), is drawn into a dust compartment under which are placed 25 filter bags, through which the cleaned air is exhausted and in which the dust collects. The bags are shaken every five hours. In this way, not only is a valuable product collected, but conditions are rendered more healthy for the workpeople. The principal advantage claimed for this material when used as filling for paints, enamels, etc., is, that it consumes only a small amount of oil, yet produces a large bulk and holds well in suspension.

PHYSICAL AND CHEMICAL PROPERTIES, TESTING, ETC.

STUDY OF TRANSITION POINTS BY A DILATOMETRIC METHOD.—P. Braesco (*Ann. Phys.* **14**, 5, 1920). Using a modification of Chevenard's differential method giving the difference between the expansion of the sample and that of a standard substance, the author determined the temperatures at which, owing to change of phase, sharp alterations in volume occur. An alloy of nickel with 10% Cr was found suitable as a standard, as the expansion of this alloy shows no irregularities up to 1000°C., and the transition point of Ni is much depressed—to – 175°—by the 10% Cr. The following were the results for silica: amorphous silica by precipitation had no transition; α quartz changed to β quartz at 575°; α cristobalite to β at 235°; α tridymite to β at 110—115° and β to γ at 145°; quartz and amorphous silica to cristobalite above 1400°; tridymite to cristobalite at 1600°; quartz to tridymite at 1300—1400°. Cristobalite is thus the stable form above 1600°, below 1600° tridymite, and at low temperatures quartz. The mean coefficient of expansion of quartz is 12×10^{-6} between 100 and 300°; 14×10^{-6} between 200 and 300°; and $21 \cdot 3 \times 10^{-6}$ between 300 and 500°. A study of clays and clay constituents brought out the following: the expansion of mica is regular up to 900°; natural clays show a decided break in their expansion at temperatures from 630—840°; kaolinite, however, showed a maximum expansion at 500°, confirming Wallach's work, who attributes the effect to dehydration of $2SiO_2.Al_2O_3.3H_2O$.

SILICIC ACID AS A MEDICINE.—(*Tonind. Ztg.*, **44**, 431, 1920). See TRANS. **19**, Abs. 132, 1920.

CARBIDE LIME AS A BUILDING MATERIAL.—(*Tonind. Ztg.*, **44**, 1186, 1920). In the production of acetylene gas, 115·6 parts by weight of calcium hydroxide are obtained from 100 parts of carbide according to the formula: $CaC_2 + 2H_2O = Ca(OH)_2 + C_2H_2$. The lime usually contains from 40 to 45% water and is in the form of a moist paste. After drying in the air, some uncombined water still remains, in addition to impurities such as silicates, carbide residues, calcium sulphide and carbon. In the samples examined

some of the lime had also been converted into the carbonate and thus become useless. The composition was as follows:

	Sample A.	Sample B.
Organic and free water	6·29%	6·98%
Silicates: Silica	2·94%	1·87%
Alumina and iron oxide ..	3·75%	4·13%
Calcium carbonate	7·82%	6·27%
Calcium hydroxide	78·63%	80·01%

The quantity of free, active lime, reckoned as calcium oxide, was 59·5% for sample A, and 60·55% for sample B. This gives 32·73% calcium oxide for sample A and 35·84% for sample B from 100 parts of the ordinary market quality in the moist condition, which means that for every 10 tons transported, about 6·6 tons are useless ballast. The finely divided carbon particles give the lime a greyish colour, whilst the carbide residues, in addition to their unpleasant smell, sometimes impart a greenish colour to mortar made from this lime. As a building material, therefore, carbide lime can scarcely be considered a satisfactory substitute for the ordinary qualities except under exceptional circumstances.

SLAKED LIME AND MILK OF LIME.—B. Kosmann (*Tonind. Ztg.*, **44**, 555, 565, 572, 602, 632, 1920). A criticism of some current literature on the subject. The writer considers that a considerable extension of the Michaelis theory of the colloidal hydrogel state of a mixture of slaked lime and water is justified. Such a mixture of caustic lime and water represents a transformation of the calcium hydroxide into a dispersoid mass corresponding to an octohydrate of calcium oxide. This change is brought about by the continual absorbtion of water and the swelling resulting therefrom. The dispersoid mass consists of an intimate mixture, mechanically and chemically bound, of a hydrogel and a hydrosol, the former being the tetrahydrate of calcium oxide containing 54% water, the latter lime-water, a saturated solution of 1·27 gr. calcium oxide in 1 litre of water. Owing to the unusual conditions under which the two component parts are mixed, the further addition of water leads to the formation of milk of lime, with any degree of lime content.

NEW FACTS ABOUT SURFACE FRICTION.—Ch. Terzaghi (*Phys. Rev.*, **16**, 54, 1920). A discussion of a number of preliminary experiments leading to an investigation of the physical properties of clays. Every plastic deformation of a clay body involves the sliding of the surfaces of the clay particles upon each other. In order, therefore, to determine the character of the laws governing frictional forces, the writer studied the behaviour of smooth glass plates placed in contact under different conditions of loading. As a result of these experiments, it is shown that the frictional resistance between two surfaces is not due to the shearing strength of a cushion of air or water, but to the existence of microscopic particles which deposit themselves on the surfaces. Frictional resistance was found to be independent of the thickness of the air cushion. A drop of water was placed betwen two glass plates and allowed to evaporate. When the thickness of the layer of water was reduced to about 100 $\mu\mu$, evaporation ceased entirely, suggesting that the molecules of a solid are able to exert forces over distances of about 50$\mu\mu$. Such thin layers of water have, beside viscosity, shearing and tensile strength. This result is used to explain the facts: (1) that layers of clay are impermeable unless the head exceeds a certain minimum; (2) that the water content of clays does not drop below a certain limit; (3) that a drop of water does not spread over a surface moistened by water. The author concludes that the ordinary laws of friction of rest apply only where contact between the surfaces must be enforced by exterior pressure. Two bodies joining each other with perfectly even surfaces would present not only a lateral resistance against displacement, but resistance against separation also.

NOTE ON THE PROBABLE COST OF BURNING MAGNESITE IN ELECTRICALLY HEATED KILNS.—W. F. Smeeth (*Records, Dept.*

Mines and Geology, Mysore State, **15**, 152, 1916). To dead-burn Mysore magnesite satisfactorily, 15 cwt. of Bengal coal would probably be required to produce 1 ton of magnesia, at a cost of Rs. 16. Experiments were, therefore, undertaken on burning magnesite in electric kilns. Some preliminary work was done by A. M. Sen to ascertain the effects of burning magnesite at various temperatures (see below). A suitable furnace was not available for temperatures above 1200°C. A selected sample of Dodkanya magnesite was obtained and analysed as follows: SiO_2 0·77%, $Fe_2O_3+Al_2O_3$ 0·42%, CaO 0·05%, MgO 45·74%, moisture 0·06%, combined water 1·25%, CO_2 50·35% (calculated). Specific gravity was 2·92, total volatile matter 51·66%. All the burnt samples slaked to slightly coherent masses on adding water; none of them could be considered as dead-burnt. For this, a temperature of 1,600° to 1,700°C. would be required. In discussing the relative merits of coal and electricity, the writer calculates that 1 ton of MgO burnt at a temperature of 1,600°C will require about 1,500 K.W. hours, which, at the Government rates would cost Rs. 47. This is about 3 times the cost of coal. The greater portion of the heat shown in the calculation is expended in driving off CO_2, and this does not require a very high temperature. It is possible that this portion of the work could be done with coal or gas, and the calcined product then transferred to an electrically heated hearth to be raised to the higher temperatures. A further advantage could be obtained by recovering some of the large amount of heat in the magnesia removed from the hearth by using it to heat secondary air or steam.

TESTS ON THE AIR-SLAKING OF MAGNESIA CALCINED AT VARIOUS TEMPERATURES.—A. M. Sen (*Mines and Geology Dept., Mysore State, Records,* **15**, 158, 1916). Some tests on the calcination of magnesite and determination of the specific gravity of the resulting magnesia as well as re-absorption by it of moisture and CO_2 were carried out in the laboratory of the Indian Institute of Science, Bangalore. The analysis of a sample of Dodkanya magnesite, powdered through a 120 mesh sieve, is given in preceding abstract. Samples were heated in a nichrome resistance furnace at 700°C., 1000°C. and 1200°C. After heating for 18 hours at 700°C. magnesite powder (passed through 30 mesh sieve) was found to have decreased in weight by 50·86%. The specific gravity of this calcined magnesia was 3·327. A portion of this magnesia was exposed to the atmosphere on a watch glass to determine its rate of re-absorption of moisture and CO_2, the increase in weight being carefully noted. The following is a summary of the results obtained from magnesite calcined at the three temperatures:

Temp. of Calcination	Total Loss % on heating	Sp. Gr. of MgO	Total gain in wt. due to absorption of moisture and CO_2 %	Approx. re-absorption of moisture %	Approx. absorption of CO_2
700°C.	50·86	3·327	12·97	7·09	5·82
1000°C.	51·03	3·334	3·86	2·20	1·89
1200°C.	51·19	3·529	1·25	0·86	0·48

The percentage rate of re-absorption of moisture and CO_2 by MgO calcined at these temperatures is set out graphically.

STUDIES ON SEDIMENTATION.—P. Rona and P. György (*Biochem. Zeit.,* **105**, 133, 1920). It was found that the sedimentation velocity of kaolin was markedly increased by non-electrolytes. The phenomenon is attributed to a sensitization of the suspended particles to the electrolytes present in the suspension by the non-electrolyte. This is supported by the fact that the sedimentation velocity of charcoal is not influenced by non-electrolytes.

STUDIES ON THE MOST FUSIBLE MIXTURES OF K_2O—CaO—Al_2O_3—SiO_2.—(*Sprech.*, **53**, 503, 1920). Taken from H. H. Hanna's paper in *Trans. Amer. Cer. Soc.*, **17**, 672, 1915.

THE REFRACTORY PRODUCTS INDUSTRY.—J. Bied (*Cer.*, **22**, 33, 1919). See TRANS. **19**, 134, 1920.

SILICA PRODUCTS.—A. Bigot (*Cer.* **22**, 61, 1919). See TRANS, **17**, 259, 1918 and **18**, 165, 1919.

THE COLLOIDAL CHARACTER OF CLAY FROM THE PRACTICAL POINT OF VIEW.—A. Bencke (*Sprech.*, **53**, 480, 1920). In general, salts lead to coagulation and bases to deflocculation of clays. By the addition of NaOH, N_2CO_3 or Na_2SiO_3 the dispersion of the clay particles is increased so that a better and more complete separation of the sandy from the actual clay substance can take place. The deflocculated clay must then be treated with an acid or salt to bring about coagulation. The treatment of clays for casting purposes is also based on their colloidal properties. By the addition of the alkali reagent (Na_2CO_3 or Na_2SiO_3) the quantity of water required to maintain the body in a liquid condition, is reduced to a minimum ; it is, in fact, not greater than that contained by the body in the plastic state. On the other hand, coagulating reagents (acids and salts) are now widely used to increase the plasticity and strength of clays and to thicken glazes and enamels. A peculiarity of these phenomena is the manner in which coagulation and deflocculation take place in phases, varying between maxima and minima, until a certain equilibrium is reached. Upon adding an alkali, for instance, to a clay suspension, a decided minimum viscosity is first produced, followed by alternate maxima and minima until the process finally moves in a definite direction and is completed. Certain organic substancess like tannin, react upon clay suspensions similarly to alkalies, but the phases are not so well marked. They render the clay more resistant to the action of electrolytes and thus assume the functions of protective colloids. The presence of impurities has a marked effect on suspensions of kaolin ; impure clays, containing soluble sulphates, can only be deflocculated with difficulty, if at all. The behaviour of a clay suspension under the influence of a direct electric current would appear to indicate that the clay particles in the suspension are charged negatively, so that the addition of negative or OH· ions leads to increased deflocculation, and H· ions to increased coagulation. Recognition of the colloidal nature of clays may lead to a satisfactory scientific method of measuring plasticity . Atterberg compiled plasticity grades based on the amount of water which had to be added to clays in order to force them through an opening of given diameter under a given unit of pressure. Plasticity is undoubtedly influenced greatly by the presence of organic substances, and the degree of acidity is also an important factor. This is the only explanation of the fact that weathering improves the plasticity of a clay, owing probably to the formation of acids by the action of bacteria. A thorough mixing of a small quantity of Al_2Cl_6 with kaolin improves its plasticity, but has no effect on impurer material. In the drying process, which brings out most clearly the colloidal nature of clays, the presence of electrolytes affects not only the degree of shrinkage, but also the capillarity of the free water in the clay. This explains why the additions of small quantities of NaCl assists in bringing the water to the surface and thus diminishes the strain on the clay during drying. On moistening dried clay, the original plasticity is not immediately attained ; the time required for this depends directly upon the temperature to which the clay has been subjected. The clay, therefore, behaves exactly like a deposited gel of any of the known colloids. In the firing treatment of clays, the removal of the hygroscopic water leaves the clay in a condition in which it readily absorbs water vapour and gases. This condition is accentuated by driving off the chemically combined water, so that sulphur dioxide and trioxide are readily absorbed. This dehydration is necessarily endothermic in character and is always accompanied by a considerable increase in the molecular volume. At about 900°C. an exothermic reaction takes place, which is probably accompanied by an irreversible change of a colloidal nature.

KAOLIN FOR TANNIN ANALYSES.—K. W. Frey (*J. Amer. Leather Chemists Ass.*, **14**, 393, 1919). For the purpose of devising specifications for a satisfactory kaolin for use in tannin analysis, experiments were undertaken to gain some idea of the purity and quality of certain American products. Six varieties of kaolin from different sources (designated A to F), were obtained, and, upon receipt, the samples were thoroughly dried at 100°C., passed through a 20-mesh sieve and bottled. Portions of each sample were digested for about 24 hours with 5% by weight of HCl, and after washing repeatedly with distilled water until the washings were neutral to phenolphthalein, were dried and bottled. The kaolins were examined for solubility (1) in water ; (2) in 0·02 normal acetic acid, and (3) in 0·5% clear tannic acid solution. The results showed the kaolins to be remarkably free from soluble matter, the highest corrected water soluble residue being 1·2 mg. per. gram. from kaolin E. Washing with HCl reduced the residue in all cases to practically nothing. The acetic acid test is apparently a little more severe, but even here, four of the samples gave less than 1 mg. residue. With tannic acid solution, kaolins produce a decided discoloration, the HCl washed samples being no better in this respect. This indicates iron or possibly alkalinity.

Clarifying Ability. Fineness was suggested to be an important factor in indicating the ability of a kaolin to give clear filtrates. Practically 100% of the washed samples passed a 200-mesh sieve, yet they varied from one extreme to the other in this respect. Observations on ignited portions were also made. When mixed with water, the ignited kaolins separated into a somewhat granular, rapidly sedimenting portion and a very fine, extremely slow settling part, which produced a faint milkiness. On testing for soluble matter, the ignited samples gave practically clear filtrates and the residues therefrom ranged from 0·3 to 1·1 mg. per gram. But with tannic acid, the ignited kaolins gave, in general, slightly hazier filtrates than did the unignited samples. For the six samples, loss on ignition varied from 13·8 to 14·5%.

Suitability for use in determining acidity of tan liquors. The test used was the same, in general principle, as that suggested by McCandlish and Lederer : To 15 grs. kaolin contained in a flask, 200 cc water and 50cc of practically 0·1 N. acetic acid were added and after a thorough shaking the flask was allowed to stand 1 hour. Fifty cc of the supernatant liquid was pipetted out and titrated with 0·1N. NaOH and hematine as an indicator. The remaining contents of the flask were then filtered through 590C.S and S., 15 cm. filter paper, 100 cc of the clear filtrate was evaporated and weighed as in the ordinary tannin analysis. A blank for both the titration and soluble matter was run, in exactly the same manner, omitting only the kaolin. The results from the titrations are expressed in ccs. of 0·1*N*. NaOH required. The residues for soluble matter, after correction for a blank from the acid and filter paper of 0·9 mg., were calculated to mgs. of soluble matter per gram of kaolin by dividing by six.

	cc. 0·1*N*. NaOH for aliquot	Mg. soluble for 1 gr. Kaolin in water	Mg. soluble for 1 gr. Kaolin in 0·02*N* acetic	Discoloration with 0·5% tannic acid as for soluble solid determination
Acid blank	9·53			
Kaolin A.—As rec'd. ..	9·51	0·4	0·5	Decided
HCl washed ..	9·51	0·0	0·2	do.
Kaolin B.—As rec'd. ..	9·39	0·5	0·4	Slight
HCl washed ..	9·32	0·4	0·0	do.
Kaolin C.—As rec'd. ..	9·51	0·3	0·4	do.
HCl washed ..	9·51	0·0	0·1	do.
Kaolin D.—As rec'd.	6·80	0·7	1·1	Practically none
HCl washed ..	6·80	0·2	0·2	do.
Kaolin E.—As rec'd.	9·32	1·2	1·8	do.
HCl washed ..	9·39	0·0	0·2	do.
Kaolin F.—As rec'd. ..	9·20	0·2	0·9	do.
HCl washed ..	9·20	0·0	0·1	do.

The following specifications for kaolin are suggested as tentative: (1) Kaolins should be preferably pure white, soft, smooth, free from sand and other gritty matter, and show no tendency to lump or "ball up" on wetting. (2) Should give clear filtrates with tannin solutions and on standing over night with distilled water should give a clear supernatent liquid, and when filtered the filtrate should not, on boiling down, be alkaline to phenolphthalein. (3) Should give on ignition a loss of from 12 to 15% on the dried sample. (4) Should not give a discoloration with a 0·5% tannic acid solution when tested according to the official method. (5) The titration of the kaolin test, as described above, should not differ from that of the blank by more than 0·25 cc. (6) The residue in above test, after deducting that from the blank and dividing by 6, should not exceed 1 mg.

REFRACTORIES FOR ELECTRIC FURNACES.—(*Iron and Coal Trades Review*, **101**, 616, 1920). A symposium on refractories for electric furnaces recently held by the Electric Furnace Association in Columbus, Ohio. The requirements for electric furnace refractories were first outlined. A new, cheap, reliable product with a melting-point above 1750°C. is now required, a substance which (1) is highly resistant to sudden temperature variations, (2) which has been calcined at electric furnace temperatures, and (3) which therefore may possess reasonable constancy of volume. It must also have the necessary resistance to scour of slag, hot gases, etc., be a poor conductor of electricity, and have sufficient strength at high temperatures to support the arches and side walls. Fireclay bricks have to be very thin, or water cooled, otherwise the inner surface melts down, or softens and absorbs slag and metal. Silica bricks melt at about the same temperature as fireclay bricks, but retain their shape and much of their strength to a high temperature. On the other hand, they must be heated or cooled at a low rate. Calcined dolomite, though cheap, air-slakes readily; its use is, therefore, confined to making tamped furnace bottoms and for patching. Magnesite bricks appear to be about the best refractory material at present. MgO is reduced by carbon at 1800°C., but is unaffected at lower temperatures by most metals. For best results its lime content should be low, and its tendency to spall may be counteracted by keeping moisture away and preventing strong temperature changes. Steel-clad magnesite blocks have been used successfully for bottoms and particularly in panels built in sidewalls at hot spots near electrodes. A soft-steel box of brick size, with one end missing, is rammed hard with ground, dead-burned magnesite. These are not burned, but after drying are laid as leaders; upon heating, the iron case melts and a "jointless" surface results, which is more porous than the pressed burned brick, and will stand more rapid temperature changes with less danger of spalling. In a chromium-vanadium steel furnace the best record on a brick lining was 30 heats, whilst 111 heats were procured from the tamped-iron blocks. Chromite bricks have not been satisfactory for many years. On account of their resistance to either acid or basic baths, however, good chromite bricks might be used for several courses in sidewalls, near the slag line. Bauxite is suitable for lining the hot zones of cement kilns. As a brick, it is difficult to make, owing to lack of a good binder. It shrinks continuously under heating, unless the raw material has been calcined and the brick burned at extreme temperatures. Alundum and carborundum, despite their cost, may easily prove economical: this has been particularly demonstrated in the case of door-jambs made from this material. Four types of carborundum are now on the market: (*a*) Recrystallized carborundum, which has been passed through the electric furnace a second time; (*b*) three kinds of bonded carborundum, small crystals bonded with certain refractory mixtures; (*c*) various cements for moulding, consisting of carborundum with different bonding materials; (*d*) firesand, a furnace by-product consisting mainly of silicon carbide. From these four types a wide variation in refractories can be obtained. In general, carborundum begins to dissociate appreciably under oxidising conditions at about 1500°C., and under reducing conditions at 1700°C. Iron, steels and their ordinary slags also decompose carborundum.

A bonded variety is made with good electric resistivity at high temperatures. During the discussion, the direction from which new and better refractories might be expected was pointed out. A study of the $SiO_2:Al_2O_3$ equilibrium diagram revealed one compound, sillimanite, with a melting point about 1820°C. It is manufactured commercially by mixing proper proportions of fireclay and bauxite, grinding and calcining at 2700 to 2800°F. in a kiln. The resulting clinker is then crushed, bonded with a little of the original slurry, slop moulded, repressed, dried and fired at the maximum temperature of the ordinary kiln 2800°F. A similar compound, spinel (MgO, Al_2O_3) also occurs in this system. It melts at about 2130°C. Like sillimanite, it should remain rigid nearly up to its melting point. It has double the life of magnesite when used for charging doorsills, and should be no more expensive. Zircon bricks, made of the mineral $ZrO_2.SiO_2$, which melts at about 2560°C., are difficult to make with a satisfactory bond. Ground ore is the best agent, but this requires a burning temperature obtainable only in an electric furnace. Fused zircon has a permanent volume. It is an acid refractory, being attacked by basic slags and hydrofluoric acid, but not by molten silica. It has a low coefficient of thermal expansion, but at the same time a low thermal conductivity; it is consequently liable to check badly on sudden temperature changes. It has a high electric resistance. All things considered, it would appear to be the most promising refractory for effecting future improvements in acid linings.

II—MANUFACTURING PROCESSES: GENERAL.

THE HOLLOW-BRICK QUESTION.—A. Hielscher (*Tonind. Ztg.*, **43**, 1183, 1919).

IMPROVEMENTS IN BRICK-MAKING PRACTICE.—A. Bührer (*Tonind. Ztg.*, **44**, 704, 1920). A short discussion, mainly from the point of view of fuel economy.

SLAKING LIME MIXED WITH SAND.—W. Drakebusch (*Tonind., Ztg.*, **44**, 1252, 1920). In the manufacture of sand-lime bricks, it is now recognised that the quantity of sand to be added to the lime must depend upon the amount of heat generated by the lime during slaking. The quality of the lime will, therefore, determine whether the whole or only a portion of the sand must be added in the slaking-drum process.

LIGHT PLASTER BRICKS.—Grossheim (*Tonind. Ztg.*, **44**, 1259, 1920). For the manufacture of light plaster bricks ordinary gypsum is generally used as a binder with the addition of coal ash, sawdust, pumice sand, etc. Good hard coal ash is preferable to sawdust; it must be free both from dust and coarse pieces, and must be stored for some time. A tank, or container, is filled one third full with water and the necessary quantity of plaster added and stirred up. The required amount (depending upon the quality of the plaster) of coal ash (or sawdust) is then added, and the whole again stirred vigorously. For 1000 bricks measuring $10 \times 12 \times 25$ cm. about 0·85 tons plaster and $1\frac{1}{2}$ cu. m. coal ash are required. After from 20 to 30 minutes the body is sufficiently hard for the bricks to be removed from the moulds and dried in the air. The machinery for making the bricks is described and illustrated.

GROG BRICKS, ETC., FOR BUILDING GLASS OVENS AND TANKS.—J. Baldermann (*Tonind. Ztg.*, **44**, 581—2, 1920).

THE NEUSS SAND-LIME BRICK WORKS.—B. Krieger (*Tonind. Ztg.*, **44**, 862, 1920). A short account of the methods of working adopted by this concern, which was founded in 1900.

THE MALINITE PROCESS FOR MAKING REFRACTORY SILLIMANITE BRICKS.—H. Sachse (*Tonind. Ztg.*, **44**, 1003, 1920). A short account of the process invented by A. Malinovsky. (See *J. Amer. Cer. Soc.*, 1920, p. 40).

COOKING UTENSILS.—E. Tuschhoff (*Tonind. Ztg.*, **44**, 729, 1920). In the brick making industry, the high temperatures necessary for firing the usual stone-ware cannot ordinarily be attained. For lower temperatures, the clay must be plastic and contain iron oxide. To withstand the stresses which occur in the ware when used for cooking purposes, the clay must be mixed with sand or grog, or both. A good body consists of 60 parts red-firing, plastic clay, 25 parts grog and 15 parts yellow-sand. After screening through a 900-mesh, the grog left a residue of 32%, and the sand 70%. The firing temperatures vary considerably according to the raw clay used. Brown ware can be fired at cone 09 to 2, but at these temperatures the body must come out very porous, in order to stand the fire in cooking. If the colour is not satisfactory, from 4 to 8% iron oxide or 6—9% manganese dioxide may be added. The glazes must be so prepared that the lead is not attacked by sour foods. The higher the firing temperature, the more intimately do the silica and lead combine, so that there is less danger of the lead in the glaze being reacted upon. A leadless glaze, which is fritted with a portion of its ingredients and then finely ground follows the formula :

$$\left.\begin{array}{l} 0{\cdot}25\ K_2O \\ 0{\cdot}25\ Na_2O \\ 0{\cdot}50\ CaO \end{array}\right\} : 0{\cdot}28\ Al_2O_3 : \left\{\begin{array}{l} 2{\cdot}4\ SiO_2 \\ 0{\cdot}5\ B_2O_3 \end{array}\right.$$

and contains 139·75 parts felspar, 95·5 parts borax crystals, 50 parts calcite and 50·4 parts sand. Of this, 268·65 parts frit and 7·77 parts kaolin are ground to make the glaze ; the firing temperature is approximately cone 05a. A lead glaze, which melts at about cone 01a, has the formula :

$$\left.\begin{array}{l} 0{\cdot}05\ K_2O \\ 0{\cdot}95\ PbO \end{array}\right\} : 0{\cdot}15\ Al_2O_3 : 2{\cdot}1\ SiO_2$$

and is obtained from 27·95 parts felspar, 216·6 parts red lead, 25·9 kaolin and 111 parts sand. The addition of 6 to 8% iron oxide gives the popular chestnut-brown colour on a red body.

STONEWARE PIPES.—(*Tonind. Ztg.*, **44**, 666, 1920). Stoneware pipes are usually considered to have dense, sintered bodies. The degree of vitrification depends upon the thickness of the pipes. In most cases, a certain amount of suction is observed on applying the tongue to a new fracture in the body. The thinner pipes made in Germany for export are found to have more even and denser bodies than the thick-walled articles, intended for the home market.

THE MANUFACTURE OF SALT-GLAZED DRAIN PIPES.—F. J. (*Deut. Töp. Zieg. Ztg.*, **50**, 190, 1919). A short survey of the method of manufacturing pipes with satisfactory resistance to pressure, the action of acids, etc. The raw material must be a plastic clay which is rendered completely dense at high temperatures, but the sintering and melting points must be sufficiently far apart to prevent the pipes from losing their shape in the kiln.

THE MANUFACTURE OF GROG WARE.—A. R. (*Deut. Töp. Zieg. Ztg.*, **50**, 214, 1919). A short, general discussion.

THE MANUFACTURE OF GYPSUM MOULDS FOR INTERLOCKING TILES.—Baschant (*Deut. Töp. Zieg. Ztg.*, **50**, 225, 1919). Gypsum is useless for this purpose unless it can be ground to a fine powder. A too rapidly setting material can be improved by adding a little milk of lime. If the gypsum is too moist, and sets too slowly, it should be screened fine and heated in an unglazed iron container. The latter is almost filled with the powder, which is well probed with a stick, to allow the moisture to escape, and then placed over a cooling chamber. In mixing, the water must be stirred vigorously while the powder is added slowly. If the mould is cast, care must be taken to see that no air-bubbles remain in the mixture.

A METHOD OF FIXING BODIES IN HOLLOW CAVITIES OF PORCELAIN OBJECTS BY SHRINKAGE, FOR THE MANUFACTURE OF ELECTRIC INSULATORS IN PARTICULAR.—H. Schomburg & Söhne, Germ. Pat., 295,467. (*Deut. Töp. Zieg. Ztg.*, **50**, 483, 1919). The inner portion is first fired alone, fitted into the outer, unburned section, and the whole then fired again. This process is said to impart a powerful grip and great mechanical strength to the insulator. A sectional sketch is given.

"BERRA"—A NEW HOLLOW FLOORING BRICK.—F. Rücker (*Deut. Töp. Zieg. Ztg.*, **50**, 538, 1919). The bricks are triangular in section and hollow.

CLAY OR STONEWARE UTENSILS FOR POULTRY FARMS.—A. Wulf (*Sprech.*, **53**, 442, 1920). A short description of the various appliances required for poultry, with sketches showing the most advantageous shapes and dimensions. Food and drinking troughs should be glazed on the inner surface.

CASTING HEAVY PORCELAIN APPLIANCES FOR ELECTRICAL PURPOSES.—(*Sprech.*, **53**, 479, 1920). Taken from a paper by H. J. Lundgren in *Trans. Amer. Cer. Soc.*, **17**, 629, 1915.

ECCENTRIC PRESSES FOR GROG BRICKS.—Anon (*Tonind. Ztg.*, **43**, 736, 1919). A short description of a machine which was introduced many years ago by the firm A. Hütwohl, in Bendorf.

"ANGLE" BRICKS.—Schoenfelder (*Tonind. Ztg.*, **43**, 753, 1919). The writer gives further details of his system of building with "angle" or frame bricks (see page 8).

A NEW ROOFING TILE.—V. R. (*Tonind. Ztg.*, **43**, 904, 1919). The writer claims to have combined the advantages of flat and interlocking tiles in a new shape (illustrated), the manufacture of which offers no special difficulty.

MOULDING BRICKS.—C. W. Bosher (*Pat. J.*, 1,645, 1920). No. 143,749, July 9, 1919. Describes a form of brick or building block with interlocking projections and recesses and vertical and cross channels.

BUILDING-BLOCKS.—C. P. Lovell (*Pat. J.*, 1,646, 1920). Nos. 144,377/8, Mar. 8, 1919. Relates to the formation of hollow bricks or building-blocks.

MOULDING BUILDING-BLOCKS.—C. H. Schol (*Pat. J.*, 1,647, 1920). No. 144,645, June 7, 1920. Description of a press for moulding building-blocks, more particularly from blast-furnace slag. The material within a mould box is forced upwards against an abutment to apply top pressure, after which the mould bottom is forced upwards to give bottom pressure.

TREATING SLAG.—Norske Akt. Elektrokemisk Ind. (*Pat. J.*, 1,644, 1920). No. 143,500 May 6, 1920. Molten slag is converted into foam by blowing steam or gas through it, and this foam is rapidly cooled to a temp. at which the slag is still plastic, but the porosity becomes stable, the resulting material being moulded into bricks, etc.

ACID-PROOF VESSELS.—W. E. Richards (*Pat. J.*, 1,669, 1921). No. 153,047, June 24, 1919. A mixture of sand or powdered glass or quartz and clay with a solution of sodium silicate is used for making acid-proof vessels. The mixture, with or without the addition of asbestos fibres, is pressed into moulds. The resulting articles are impregnated with a bituminous liquid, or otherwise.

TREATING CLAYS.—W. Smith (*Pat. J.*, 1,659, 1920). No. 149,440, May 13, 1919. The clay is heated together with a material containing volatile carbon compounds, such as bituminous or oil shale, with the exclusion of air, the excess carbon being left within the mass of the article. The clay may be impregnated with volatile carbon compounds, or the biscuited articles may be charged with liquid or gaseous carbonaceous compounds and heated with

the exclusion of air. The firing may be effected by embedding the clay article in powdered coke or oil shale, and the temperature used may be sufficient to seal up the carbon in the clay. The carbonised clay may be treated with clay slips, glazes or enamels. Abrasives may be formed by saturating clay with carbon as above, heating to a very high temperature (1,600°C.) and grinding the material.

COMPOUNDING AND PREPARATION OF BODIES, ETC.

REFRACTORY SUBSTANCE.—L. Denis (*Pat. J.*, 1,646, 1920). No. 144,359, Mar. 5, 1919. A refractory substance suitable for use in surface combustion is made by burning a mixture of pure rich refractory earth containing 70—80% of sand, magnesia, a poor light earth containing over 80% sand, and sawdust. Suitable proportions are : 30 parts rich earth, 30 magnesia, 25 poor earth, and 5 sawdust. The product is heated to at least the temp. it will be subjected to in use.

REFRACTORY SUBSTANCES.—British Thomson-Houston & Co. (*Pat. J.*, 1,642, 1920). No. 142,721, Aug. 19, 1919. A refractory substance is formed of a mixture of magnesia which has been fused, crystallized, and crushed and magnesia which has been heated to a lower temperature and will further shrink on heating, and which may be obtained by heating a magnesium compound such as the carbonate or hydrate to about 700°C. A binding agent such as magnesium sulphate or chloride, or ferrous sulphate is added. The composition, moistened with water, is pressed into position as a furnace lining or moulded to form bricks, crucibles, etc., which are heated up slowly to decompose the binding agent, and ultimately to 1700—1900°C. or higher.

REFRACTORY SUBSTANCES.—G. L. Dimitri (*Pat. J.*, 1,642, 1920). Nos. 142,512 and 142,513, May 1st, 1920. Natural magnesium silicates, such as talc, steatite, Briancon chalk, are mixed in a powdered state with a flux consisting of natural or artificial multiple silicates such as felspar, mica pyroxene, or with rocks containing them, as granite gneiss, porphyry, pegmatite. The mixture is prepared moist or in powder form, dried, shaped, and burnt at a temp. of about 1450°C. to produce refractory and electrical insulating articles. In the process of manufacture by compression, the latter is effected in a vacuum. Powdered material is placed in a cylinder with an air-tight piston and a head with a passage, through which air can be exhausted. Placed above the powder is a loose-fitting washer, which prevents the powder from being drawn up the tube.

A DIAGRAMMATIC METHOD OF CALCULATING CERAMIC RECIPES.—A. Pfoff & M. Donath (*Ber. D.K. Ges.* **1**, No. 2, 21—32, 1920). Indicates a method of utilising the triangular diagram for calculation purposes for mixtures containing three, four or more components. A number of diagrams is given to illustrate the method.

REFRACTORY CRUCIBLES.—Anon (*Metal Ind.*, **17**, 369, 1920). It has been found possible to make crucibles from highly refractory oxides and minerals without using clay as binder. One method is to tap the plastic mass inside a fireclay mould lined with plaster of Paris. When the mould and the crucible are fired to a red heat, the plaster of Paris disintegrates and the crucible can then be removed from the mould. The crucible is then fired to a high temperature to give it the necessary density and strength. The other method is to mix linseed oil with a refractory oxide and then to shape the crucible inside a detachable metal shell. The crucible is then baked in this shell in a coke oven, after which, the shell is removed and the crucible is fired to a high temperature, when the temporary carbonaceous binder is burned out and the refractory oxides sinter. Crucibles have been formed in this way from titanium dioxide, zirconium dioxide, and carborundum fire sand.

GLAZED RETORTS; PREVENTION OF CRACKING.—H.M. (*Tonind. Ztg.*, **43**, 1259, 1919). For retort bodies, the grog should contain the proper proportion of medium and large grain, up to 8 mm. The body must be very carefully worked up, passed through the pug-mill until quite soft, and then transferred to moulds measuring 300 × 150 × 100 mm. After drying for a few days, it is stored for about 2 weeks, care being taken to exclude air and light as far as possible. Glazed retorts retain heat longer than unglazed ware. When the firing is complete, the temperature of the kiln should be maintained for 24 to 36 hours, according to the size of the kiln.

"DEVA" FLOORING TILES.—(*Tonwar. Ofen. Ztg.*, **43**, 96, 1919). A tile of exceptional durability is made of pure machine-ground quartz rock, to which is added a chemical mixture of caustic lime and alumina to hold the body together after pressing. The actual binder is the silica contained in the raw material. The special advantages claimed for "Deva" tiles are: (1) that they do not wear smooth; (2) their acid-proof quality.

HARD STONEWARE BODY FOR ELECTRIC INSULATORS.—(*Sprech.*, **53**, 533, 1920). A suitable body, which fires satisfactorily at cone 6—8, corresponds to the formula: $\left.\begin{matrix}0{\cdot}56\ KNaO \\ 0{\cdot}44\ Ca(Mg)O\end{matrix}\right\} : 1{\cdot}6\ Al_2O_3 : 9{\cdot}2\ SiO_2$

PREPARATION OF BODIES FOR STONEWARE FLOOR TILES.—E. Tuschhoff (*Tonind. Ztg.*, **44**, 409, 431, 449, 1920). See also TRANS. **19**, Abs. 162, 1920.

GROG.—Anon. (*Tonind. Ztg.*, **43**, 834, 1919). A short account of methods for making or procuring suitable grog for refractory bricks, etc.

NEW REFRACTORIES.—Anon. (*Tonind. Ztg.*, **43**, 1152, 1919). On March 7th, 1914, A. Desgraz took out a patent in Germany for the manufacture of refractory bodies, for metallurgical, chemical and ceramic purposes, from substances in a powdered form and not readily vitrifiable. As is well-known, certain metallic oxides (*e.g.*, those of iron and manganese) combine at high temperatures with certain sulphates to form vitrifiable compounds. Zirconia, or calcined magnesite, finely ground, mixed with ground and calcined gypsum and iron oxide, iron alloys or powdered iron filings, moistened with the correct amount of water, gives a mixture which may readily be worked up into any desired form. When submitted to high temperatures, the metallic oxides and the calcium sulphate react in the usual way, forming a readily vitrifiable compound, which causes the whole of the powdered mass to sinter completely.

RENDERING NON-PLASTIC MATERIALS PLASTIC.—A. Walter, (*Pat. J.*, 1646, 1920). No. 144,317, June 4th, 1920. Small quantities of neutral or alkaline vegetable extracts are added with alkalies to clay or kaolin masses, or non-plastic materials which are liquified with difficulty by the addition of alkali alone. Neutral water-soluble saponines or extracts of saponine-bearing plants such as seatwort, cookweed, sowbreads, ivy, chestnut capsules are especially suitable. Alkaline cellulose-waste lyes and "celluar pitch" can also be used.

PORCELAIN CEMENT.—Porzellanfabrik Kahla (*Pat. J.*, 1648, 1920). No. 145,026, June 14th, 1920. A substance having a smaller coefficient of expansion than porcelain, *e.g.*, quartz glass, is added to cement to produce a composition for cementing porcelain.

PLASTIC COMPOSITION.—L. Gauthier (*Pat. J.*, 1,650, 1920). No. 145,514. June 22nd, 1920. A mixture of about 60 parts talc, 30 gelatine, and 10 hide glue, with or without zinc oxide and colouring matter, is referred to. For the manufacture of hollow ware, the composition is heated to about 70°C. in a water-bath and poured into moulds. The mass solidifies from the exterior, and when a sufficient thickness is attained, the excess paste is poured out. After moulding, the body is dried in the air, polished and treated with a solution of alum and formol. Articles thus made may be coated with a

waterproofing composition, and in the case of dolls, the interior may be coated with gumlac and sand to allow movable eyes to be fitted.

REFRACTORY SUBSTANCES.—A. Rollason (*Pat. J.*, 1,677, 1921). No. 156,447, Apr. 21, 1920. A refractory material for lining furnaces is made by roasting at about 1,800°C. magnesite or dolomite in granular form with from 5 to 10% of basic slag in an internally-fired rotary kiln having a basic lining. From the kiln the material passes into an annealing chamber, where it is allowed to cool slowly.

FUSED ALUMINA FOR ABRASIVE PURPOSES. Carborundum Co. (*Pat. J.*, 1,661, 1920). No. 150,116, June 18, 1919. A fused alumina, containing from 0·2 to 1·3% of titanium oxide and less than 0·8% each of iron oxide and silica, is obtained by fusing in an electric furnace a mixture of aluminous material such as bauxite, clay, emery, etc., with enough carbon to obtain a product containing 90% alumina, cooling, crushing, separating metallic particles, and again fusing with a small quantity of carbon. For the second fusion waste or dust from alumina, which has been fused for abrasive purposes, may also be used, but in all cases carbon is employed in the final fusion. The product is used for abrasive purposes such as grinding-wheels, and is preferably agglomerated by ceramic material. A suitable composition is: abrasive grains 80%, albany clay or other fusible clay 14%, stoneware clay 5%, and felspar 1%. This mixture is fired to 1,350°C.

SHAPING, MOULDING, DRYING, ETC.

DRY PRESSING.—K. Dümmler (*Deut. Töp. Zieg. Ztg.*, **50**, 465, 1919) A short general account.

A DRYING CHAMBER UTILISING HOT AIR OR WASTE GASES, OR BOTH TOGETHER.—W. Eckardt & E. Hotop. Germ. Pat., 298, 732 (*Deut. Töp. Zieg. Ztg.*, **50**, 518, 1919). The hot air and gases are conducted into the chamber by two separate flues extending the whole length of the drying chamber.

THE MANUFACTURE OF FLOWER POTS.—A. Harris (*Tonwar. Ofen. Ztg.*, **43**, 108, 1919).

MAKING ROOFING TILES.—H. K. (*Tonind. Ztg.*, **44**, 439, 1920). The mouthpiece of the expression machine should be so arranged that the friction in the clay is slightly less at the sides than in the centre. The end of the column of clay is then somewhat concave. This is claimed to be an advantage in drying the thin tiles.

ACID-POTS.—H. T. Arrowsmith (*Pat. J.*, 1,674, 1921). No. 155,373, Sept. 17, 1919. Acid-pots for white-lead manufacture are moulded with two or more projections on their upper edges, the insides are glazed and the pots are stacked mouth to mouth to enclose the glazed portions. They are fired without saggers, and may be of round, square, hexagonal, or other form, but are preferably square to economise oven space.

TEA-POTS, ETC.—E. Sadler (*Pat. J.*, 1,676, 1921). No. 156,051, June 22, 1920. The base of a tea or coffee pot, etc., is larger than the upper part of the vessel, and the handle, spout, and a gripping device are so arranged that they do not project beyond the area of the base. The handle consists of a vertical rib spanning a recess.

ELECTRIC INSULATORS.—A. Renandin (*Pat. J.*, 1,684, 1921). No. 159,198, Feb. 18, 1921. Deals with shapes of insulators in horizontal and vertical series. The horizontal type comprises 2 cups of oval section with symetrical planes perpendicular to one another, each cup having an inner cup. For a vertical series single cups are used with 2 interior cups.

TEA-POTS, COFFEE-POTS, ETC.—W. H. Mitchell (*Pat. J.*, 1,671, 1921). No. 154,034, Oct. 3, 1919. The spout of a tea or coffee-pot is provided with an upwardly projecting bridge-like piece near the mouth to prevent liquid

from dripping from the outlet. The bend of the spout is high up and rather sharp, and the top is nearly level with the top of the pot. The outlet is shaped to slope backward.

TUNNEL BRICK-DRIERS.—T. Entwistle (*Pat. J.*, 1,672, 1921). No. 154,966, Aug. 16, 1919. The heat from those chambers of a continuous kiln in which burning has been completed is conducted by means of an arrangement of flues and fans to damper-controlled ducts beneath the drying-chambers, the floors of which are open so that the gases rise around the goods conveyed through the chambers.

DRYING-MACHINE.—T. Allsop & W. W. Sibson (*Pat. J.*, 1,672, 1921). No. 154,986, Sept. 3, 1919. The machine consists of an enclosure divided into a heating and a drying compartment, an endless conveyer travelling over a sinuous course within it. Means are provided for circulating air between the heating and drying compartments in the general direction of the travel of the conveyer.

MOULDING TEA-CUP HANDLES.—W. H. Edwards & Edwards & Sons (*Pat. J.*, 1,655, 1920). No. 148,032, June 7, 1919. Tea-cup handles, etc., are moulded by the use of two metal dies, of which the lower one is fixed while the corresponding upper one is raised and lowered after the shaping operation. The handle is dislodged from the lower die by a spindle, which passes through an aperture in the die and is carried by a rod raised and lowered by a treadle. The upper die is raised and lowered by a balanced lever, which carries a toothed sector engaging with rack teeth on the plunger.

MOULDING HOLLOW-WARE.—L. Cucurny y Sanmarti (*Pat. J.*, 1,667, 1920). No. 152,635, June 18, 1920. Hollow articles are moulded from plastic material by forcing it against the walls of a rigid mould by means of an elastic core supported by a head and distended by pressure-fluid admitted through a passage in the stem.

FLOWER POTS.—E. Tuschhoff (*Tonind. Ztg.*, **44**, 529, 1920).

KILNS, OVENS, MUFFLES; FIRING TECHNIQUE, ETC.

THE UTILISATION OF ASHES FROM PORCELAIN AND EARTHENWARE KILNS.—M. Sauer (*Ber. D. K. Ges.*, **1**, No. 2, 48, 1920). It has been shown by experiment, that the ashes from kilns are quite suitable for firing boilers, particularly with undergrate blowers. A mixture of equal parts of lignite briquets and ashes was used to fire a boiler, the working efficiency of which had previously been determined with a fuel of known calorific value. Only the coarser slag and other impurities were removed from the ash, which was taken from a kiln fired with a mixture of wood and coal. The resulting calorific value of the ash was approximately 2120 Cal. Before using the ash, it is advisable to screen through a fine sieve to remove the dust.

THE UTILISATION OF WASTE HEAT IN ANNULAR KILNS.—R. Rieke (*Ber. D. K. Ges.*, **1**, No. 1, 36, 1920). At the request of the German Ceramic Society, the writer undertook to investigate the Krantzberger system, which has been installed by 26 firms in the German porcelain and earthenware industry. The principle consists merely in drawing the hot air from the cooling chambers of the kiln by means of a fan, and conducting it through pipes to the rooms which require to be warmed. With careful handling of the apparatus and, if necessary, the erection of screens, etc., practically all penetration of dust and ashes from the kiln into the rooms can be avoided. The system is in use for heating both drying chambers and workshops situated in some cases at a distance of 125 metres from the kilns. As a fuel-saving device, the writer feels justified in recommending the system, its only drawback being the present high cost of installation.

A NEW CERAMIC FIRING PROCESS.—K. M. Balley (*Chemiker Ztg.*, **45,** 75, 1921). Throughout the fine ceramic industry, the greatest technical difficulties are met with in firing ware in muffle or saggar ovens. The greatest care is necessary to prevent damage to the ware owing to the reducing or premature oxidising action of the atmosphere in the kiln.

Under the most favourable working conditions, the muffles or saggars, which are porous, can only protect the goods from fire-dust; the gases penetrate through the pores, and, according to their nature (chemical composition), exert a reducing or oxidising influence on the ware being fired. To counteract this influence, only hard coal of known quality is used; but even then, owing to the sulphur content of the gases of combustion, the colour and glaze of the ware are liable to be adversely affected.

As the result of systematic investigation undertaken by the writer, the following *modus operandi* was found to give the most satisfactory solution of this problem. By means of a pre-heated and filtered gas, an excess of pressure is created inside. For oxidising processes, air or oxygen would be used, for a neutral atmosphere, nitrogen, and for a reducing fire, hydrogen or CO. An excess of pressure equal to 5 mm. ($\frac{1}{5}$ inch) water-gauge above that in the flues is sufficient for this purpose. In this manner any desired atmosphere can be maintained throughout the firing period, and the ware cannot be damaged by the penetration of injurious gases through cracked or porous muffles or saggars.

A very important consideration in connection with this method—particularly during the present coal crisis—is the fact that any quality of coal may be used without risk of spoiled ware. The kiln may be fired, for instance, with powdered coal, when the temperature can be kept under complete control.

The writer's object in publishing this information was to indicate a method of obtaining satisfactory products without regard to the quality or calorific value of the fuel supply.

FIRING WITH BROWN COAL.—(*Tonind. Ztg.*, **44,** 1148, 1920). Two illustrations are given of a method of firing boilers with step grates.

THE RECONSTRUCTION OF GRATES FOR FIRING WITH LIGNITE AND BRIQUETTES.—O. Schöne (*Tonind. Ztg.*, **44,** 1185, 1920).

BURNING LIME WITH COAL WITH HIGH SULPHUR CONTENT.—Ed. Donath (*Tonind. Ztg.*, **44,** 1260, 1920). As is well known, the sulphur combines with the lime to form calcium sulphide and finally calcium sulphate, and these impurities pass into the quick lime. The writer's own experience tends to support the view that the sulphur, in the form of pyrites, is also responsible for other undesirable features. On burning first quality limestone in an annular kiln, it was found that the pieces in close proximity to the fires were coloured brown to greyish black on the outside. The coal used contained 1·28% sulphur. The brown coloration on the limestone was soluble in warm HCl, and the solution contained iron oxide and the other ash constituents in addition to much H_2SO_4. The presence of H_2SO_4 was also readily detected inside the encrusted pieces of limestone. Fused with soda and saltpetre the crust gave a distinct blue-green coloration indicating manganese. The carbonaceous (organic) matter in the coal dust, which is deposited on the limestone is burned away, leaving a coating of pyrites over the limestone, so that iron oxide and some manganese oxide remain on the surface, giving it a dark coloration, whilst the sulphuric acid penetrates deeper into the limestone.

THE MANUFACTURE OF WOOD BRIQUETTES.—O. Brandt (*Tonind. Ztg.*, **44,** 1292, 1920). Owing to their high moisture content, loose shavings and sawdust have a calorific value of only 1800 to 2000, whilst pressed briquettes made from this material after drying possess heating powers ranging from 3800 to 4000 cal. Waste tarry matter from breweries, or better still, sulphite pitch, is used as a binder, the mixture of shavings, sawdust and binder being warmed before pressing. Machines for making the briquettes are described and illustrated.

UNDERGRATE BLOWERS.—L. Schmitt (*Tonind. Ztg.*, **44**, 938, 1920). The writer discusses the merits of the 3 types of blowers and gives the preference to the propeller blower driven directly by steam turbine. The relative efficiency of the 3 systems is shown in the following table :—

Type	Steam consumption	Heat consumption		Coal consumption
		cal.	%	
Steam-jet blower ..	410 kg.	27500	11·5	70 kg.
Electro-Motor fan ..	28 kg.	18800	0·78	4·7 kg.
Propeller driven by steam turbine ..	4·9 kg.	4000	0·17	1·0 kg.

WHAT HAPPENS DURING FIRING.—R. Seydel (*Tonind. Ztg.*, **44**, 951, 1920).

FIRING STONEWARE PIPES.—W. Schuen (*Tonind. Ztg.*, **44**, 1001, 1035, et seq., 1920). Indicates a method of arriving at a thermal "balance sheet" both for hard and brown coal.

THERMAL "BALANCE-SHEET" OF AN ANNULAR KILN.—R. Claus (*Tonind. Ztg.*, **44**, 1009, 1920). Describes a method of determining the thermal values.

THE EFFECT OF THE FIRING PERIOD ON THE VITRIFICATION OF CLAYS.—H. Sachse (*Tonind. Ztg.*, **44**, 1025, 1920). Taken from a paper by G. H. Brown & G. A. Murray, in *Trans. Amer. Cer. Soc.*, **15**, 193, 1913.

UNDERGRATE BLOWERS.—L. Friedländer (*Tonind. Ztg.*, **44**, 1044, 1920). The writer disputes the figures given by L. Schmitt (above), and claims that the undergrate fan gives the best working results.

FIRING WITH ARTIFICIAL DRAUGHT.—H. Sa. (*Tonind. Ztg.*, **44**, 1045, 1920). Sketches are shown of grates with injectors and air pipes, with nozzle apparatus, adjustable steam distributors, etc.

THE "HERDA" KILN.—(*Sprech.*, **53**, 535, 1920). The "Herda" Kiln consists of a number of chambers, arranged after the manner of an annular kiln. The chambers are connected by flues in such a way that the hot air from the cooling chambers becomes thoroughly mixed in the flues with the gases of combustion from the chambers being fired. This mixing of hot air and gases leads to complete combustion of any carbonaceous matter remaining in the smoke gases, so that, in contrast to other systems, the ware is preheated with hot, dry gas, instead of with wet and moisture laden smoke gases.

POWDERED-FUEL FURNACE FEEDER.—J. J. C. Brand (*Pat. J.*, 1647, 1920). No. 144,763. Mar. 11th, 1919. In an air-current apparatus for supplying powdered fuel to furnaces, fuel is fed from a hopper to a fuel circuit, whence it passes to a screw conveyer, is mixed with a fraction of the air from an air-main, and is fed by the conveyer to a pipe in which it is mixed with another current of air and through which it is conducted to the furnace.

AN UNDERFEED STOKER.—Underfeed Stoker Co. (*Pat. J.*, 1,650, 1910). No. 145,499, June 21, 1921. A description of a stoking apparatus.

BLAST-HEATER FOR GAS GENERATORS.—Eisenwerks Jagstfeld Ges. (*Pat. J.*, 1,650, 1920). No. 145,540, June 22nd, 1920. A blast-heater and gas-cooler for use with gas generators is described.

POWDERED-FUEL FURNACE.—Fuller Eng., Co. (*Pat., J.*, 1,651, 1920). No. 146,085, Mar. 29, 1920.

GAS PRODUCER.—Soc. Française de Travaux et Const. de Fours. (*Pat. J.*, 1651, 1920). No. 146,124, June 23, 1920. In a gas producer using coke, the upper part is used to contain the fuel, which passes into the hot zone at a

rate dependent upon the ash discharge. The lower part is made of metal and provided with a water jacket for cooling purposes.

FEEDING PULVERULENT-FUEL FURNACES.—J. E. Muhlfeld, No. 143,817; V. Z. Caracristi and J. E. Muhlfeld, No. 143,818; V. Z. Caracristi, No. 143,819; and V. Z. Caracristi and J. E. Muhlfeld, No. 143,820 (*Pat. J.*, 1,645, 1920). Feb. 24, 1919. A description of various methods and apparatus for feeding powdered fuel to furnaces.

FURNACE VALVES.—Wellman Smith Owen Eng. Corporation and A. V. Kemp (*Pat. J.*, 1,646, 1920). No. 144,127, July 12, 1919. A description of a reversing-valve for controlling the flow of gases or vapour, more particularly adapted for regenerative furnaces.

TUNNEL KILNS.—G. H. Benjamin (*Pat. J.*, 1,646, 1920). No. 143,974, Mar. 6, 1919. A description of a tunnel kiln for treating bath-tubs, etc., which have to be sprinkled with coating material while at a high temperature and are then further heated in order to vitrify the coat. Between the preliminary and final heating sections is a coating-section, which can be shut off from the other two by doors. Any suitable heating-means may be used; that preferably employed comprises hot-blast stoves in conjunction with internal-combustion chambers fired by gas and each independently controlled so as to vary the heating as required along the kiln. The three sections need not necessarily be arranged in line.

ELECTRODE FURNACE.—D. F. Campbell, W. S. Gifford, and H. S. Waite (*Pat. J.*, 1,647, 1920). No. 144,438, Apr. 25th, 1919.

ELECTRODE FURNACE.—Br. Thomson-Houston Co. & H. Hastings (*Pat. J.*, 1,647, 1920). No. 144,303, July 17, 1919. In a 3-phase furnace with more than two movable electrodes, one arc is regulated in accordance with its current strength, while each of the other arcs is regulated to maintain constant relationship between its pressure and that of the first arc.

POWDERED-FUEL FURNACE.—J. E. Kennedy (*Pat. J.*, 1,647, 1920). No. 144,724, June 11, 1920. The combustion of pulverulent fuel is effected in one or more elongated combustion chambers, formed of refractory material, to which the fuel is supplied under pressure through nozzles.

OPEN-HEARTH FURNACES.—J. S. Shaw (*Pat. J.*, 1,647, 1920). No. 144,744, Dec. 21, 1918. In furnaces for melting glass and other purposes, air passes from inlets at the front of the furnace through a number of passages beneath the bath to the rear, whence it is conveyed by vertical passages to a chamber in the crown and passes by ports to the furnace. Gas is delivered to the furnace through ports alternating with the air-ports. The waste gases pass from the rear of the furnace.

LIQUID-FUEL BURNER.—H. Clements (*Pat. J.*, 1,647, 1920). No. 144,749, Feb. 12, 1919.

TUNNEL KILNS.—G. H. Benjamin (*Pat. J.*, 1,645, 1920). No. 143,652, Nov. 6, 1919. A tunnel kiln for the manufacture of tiles, pottery, bricks, etc., is heated by structurally independent combustion chambers arranged longitudinally in line on each side of the tunnel and separated from the walls and roof so as to leave air passages, the chambers being as high as the maximum height of the goods under treatment and having such an interiror capacity as to permit free combustion of the gaseous mixture. Gas and air under independent control for each combustion chamber are supplied by pumps. Circulation of air over the backs of the combustion chambers and downwards through the goods to outlets in the truck floors is maintained by another pump for each section of the kiln, or by manipulation of valves where a single pump is employed. The hot gases after leaving the chamber may heat the incoming circulation air.

TUNNEL KILNS.—G. H. Benjamin (*Pat. J.*, 1,645, 1921). No. 143,653, Mar. 6, 1919. In this case, the heating or firing chamber is heated by hot air

from hot-blast stoves externally arranged and such air is additionally heated at desired points along the kiln by passing over combustion chambers within the chamber, or over electric heaters in certain interior flues. The hot-blast stoves, heated by gas burnt in combustion chambers, are worked in pairs, one pair being heated while the other is supplying hot air.

SPRAY BURNERS.—Westf. Gasglühlicht-Fabrik & G. Killing (*Pat. J.*, 1644, 1920). No. 143,231, May 11, 1920. A spray burner has its nozzle and needle valve formed of ceramic material.

FURNACE REGENERATORS.—A. B. Chantraine (*Pat. J.*, 1,644, 1920). No. 143,244, Aug. 8, 1914. A description of special tubular blocks for building up a continuous regenerator.

GAS-GENERATORS.—J. H. Corthesy (*Pat. J.*, 1,644, 1920). No. 143,361, Apr. 12, 1919. Gas is generated by causing a gas flame to impinge on a stream of powdered fuel and passing the gaseous products through an incandescent mass of coke or refractory material. The apparatus is described and illustrated.

ELECTRODE AND INDUCTION FURNACES.—J. R. Zubiria (*Pat. J.* 1,644, 1920). Nos. 143,503/4, May 10, 1920.

STOKING APPARATUS.—J. H. Roach (*Pat. J.*, 1,644, 1920). No. 143,522, May 17, 1920. An illustrated description of an under-feed stoking device.

BRICK KILNS, ETC.—A. W. F. Weijers (*Pat. J.*, 1,643, 1920) .No. 142,803, Apr. 26, 1920. In a down-draught kiln for bricks, tiles, etc., the firing arrangements comprise one or more fuel receptacles operated as producers or retorts, part of the air supply being delivered for primary combustion through openings and part being conducted past the receptacles through channels for secondary combustion. Baffles are arranged to deflect the secondary air over the fuel receptacles, which are fed with fuel through the usual overhead passages.

BLAST APPARATUS FOR FURNACES.—H. Stansfield (*Pat. J.*, 1,643, 1920). No. 143,010, Apr. 30, 1919. Steam is supplied over the fire by a flat horizontal nozzle, and air introduced below the bars by a steam nozzle directed into an open-ended tube extending to a point near the rear of the grate, some of the air passing upwards through the firebridge.

CRUCIBLE FURNACE.—A. E. White (*Pat. J.*, 1,643, 1920) No. 143,117, Sept. 10, 1919. A slab for supporting one or more crucibles in a gas-heated furnace, especially for the treatment of glass, is adapted to receive the molten material in case of fracture of the crucible and carry it away through a pipe or channel.

ELECTRODE FURNACES.—W. E. Moore (*Pat. J.*, 1,644, 1920). No. 143,176, Feb. 14, 1919.

ELECTRIC FURNACES.—D. F. Campbell (*Pat. J.*, 1,670, 1921). No. 153,951, Aug. 14, 1919. A description of an electrode furnace, so arranged that it can be heated at will either by an arc between the electrodes or by the resistance of a layer of material such as pitch or petroleum coke, into contact with which the electrodes are tilted.

TUNNEL KILNS.—T. Teisen (*Pat. J.*, 1,642, 1920). No. 142,710, July 16, 1919. In a furnace, such as a glass-annealing kiln or lehr, any desired temperature gradient is obtained by means of a number of dampered outlets spaced along the tunnel and connected to a common flue below the tunnel communicating by two or more dampered connections with the chimney. Hot waste gases can thus be withdrawn as desired along the tunnel, while cold air entering at the exit end is prevented from causing a two sudden drop of temperature. The heating chamber is fired from a combined producer, the hot gas from which is either burnt before entering the chamber, or in the chamber itself. The secondary air may be heated by contact with the flue or in the walls of the producer. The goods may be exposed to the hot gases or enclosed within a muffle.

LIQUID-FUEL BURNERS.—Soc. Anon. des Etablissements Ballot (*Pat. J.*, 1,669, 1921). No. 153,299, Oct. 20, 1920. A sprayer for a liquid-fuel burner comprises a sleeve, on the circumference of which are conduits, formed by a multiple thread and starting from a groove supplied with liquid fuel from a conduit. Air enters by another conduit and mixes with the oil in a chamber, the outlet of the mixture being controled by a valve, the spindle of which passes through the sleeve.

LIQUID-FUEL BURNERS.—W. Dederich & S. Willner (*Pat. J.*, 1,669, 1921). No. 153,338, Apr. 30, 1919. In one form of construction, viscous material, such as tar, is preheated by passing through a passage heated by steam, and injected by the steam to a chamber and on to an impact surface also heated by steam from a nozzle. The liquid fuel and steam pass from the chamber to a nozzle and strike a second impact surface, where vaporization is complete before discharge from the burner. The air supply to the burner can be regulated. In another form, the first impact surface is constituted by the main steam-supply nozzle, the second, by a contraction of the bore and a nozzle.

A LIQUID-FUEL BURNER.—J. A. Dobble (*Pat. J.*, 1,669, 1921). Jan. 16, 1920, No. 153,204. The fuel is delivered through a pipe on a rotary cup driven by a motor. A fan secured below the cup drives air up past the periphery of the cup, where it mixes with the spray discharged from the side wall. At one side of the casing is an ignition chamber into which projects an electrode. A mixture of air and fuel is forced into this chamber and ignited by a spark between the electrode and the wall of the cup.

FILTERING GASES.—N. Klarding (*Pat. J.*, 1,669, 1921). No. 153,263, Oct. 28, 1920. Generator gases are purified by passing through agitated layers of granular filtering material from which the dust is removed by a branch stream of the purified gas. The material is fed into an upper funnel-shaped portion of a shaft and passed down through a second funnel on to a vibrating sieve. Dust is removed by the shaking and falls into a hopper, the cleaned material passing into a shaft, from the bottom of which it is returned to the upper funnel. The gas passes in through an aperture and after filtering escapes by a valved outlet. A portion of the cleaned gas is passed back through a shaft, and assists in removing the dust from the material on the shaking tray.

FURNACE CHARGING.—F. Clements (*Pat. J.*, 1,669, 1921). No. 153,032, May 5, 1919. In a furnace-charging-apparatus of the kind in which an auxiliary rotary bell-hopper is mounted above a main bell a shoot is so arranged above the upper hopper that the materials delivered thereto will not be distributed evenly round the bell, but will accumulate in a heap at some point of the periphery. The upper hopper can then be rotated through any desired angle, and the material will be delivered to the corresponding part of the furnace. Two shoots are provided, and are so placed that the material will be delivered in two separate heaps to the hopper.

ROTARY GRATE.—L. Tréfois (*Pat. J.*, 1,669, 1921). No. 153,163, Oct. 14, 1919. A rotary grate for gas-producers, etc., formed of a number of concentric annular grates turning in opposite directions relatively to each other, has regularly distributed slots or holes each covered by grid-like or perforated auxiliary grates having the forward side open for the discharge of ashes. The annular grates may have a continuous or intermittent motion, and the speed of one or more may be varied.

TUNNEL FURNACES.—Dowson & Mason Gas Plant Co. Levenshulme & J. Paton (*Pat. J.*, 1,670, 1921). No. 153,511, Feb. 14, 1920. In a gas-fired tunnel furnace intended more particularly for tinplate annealing, the burners are arranged in the bottom at one or both sides and air for combustion is heated in the side walls. The air enters the heating flues near the ends of the firing zone, flows towards the ends of the furnace, thence back to the firing

zone into flues from which it is delivered into a space between the gas ports and the burner-mouths.

FURNACE FEEDER.—T. R. Alexander (*Pat. J.*, 1,670, 1921). No. 153,535, May 6, 1920. Description of an apparatus for feeding fuel by gravity through shoots from overhead bunkers. Means are provided for measuring the coal supplied.

ELECTRIC FURNACES.—E. L. Swalley (*Pat. J.*, 1,670, 1921). No. 153,701 Aug. 22, 1919. Relates to a removable heating-unit for a crucible or other furnace, consisting of a hollow muffle with longitudinal grooves on its exterior surface, and a preformed resistance grid, the parallel lengths of which fit into the grooves.

PRACTICAL ECONOMIES IN FIRING POTTERY.—E. Reutlinger (*Ber. D. K. Ges.* **1** (3), 20, 1920). The object and aims of "heat-economics" in the Ceramic industry are : (1) improved management and control, so as to eliminate all unnecessary fuel consumption ; (2) recuperation and utilization of unavoidable heat losses from boilers, generators, kilns and machines for heating and drying purposes and for generation of steam ; further, the creation of auxiliary power by re-heating low-pressure steam for driving steam engines before being used for heating purposes. Visits to the larger potteries have invariably shown that much remains to be done in both respects. In the majority of cases it was shown that the various defects could easily be remedied by the simplest means. Heat-economising work must deal simultaneously with three subjects : (1) the kilns ; (2) firing (generators and boilers) and power, heating and drying plants ; (3) the coordination of these two sections, which are generally treated and managed separately. The article deals with the subject in general terms, the object being to induce cooperation between the German Ceramic Society, or its individual members, and the Society of Engineers for Heat-Economy (Ingenieurgesellschaft für Wärmewirtschaft).

HEAT-SAVING INVESTIGATIONS ON KILNS.—E. Reutlinger (*Ber. D. K. Ges.*, **2**, 33, 1921). In December, 1920, the Society of Engineers for Heat-Economy, of Cologne, took over the functions of "Oven and Kiln Section" of the German Ceramic Society. Its first task was to systematize the firing methods of the kilns at present in use (which hitherto had been conducted in a more or less haphazard way), so as to fulfil the following conditions : (1) to produce first class ware with as few "seconds" as possible ; (2) to adapt the firing plant to the low-grade fuel at present available, and to reduce to a minimum both the fuel consumption and the period of firing. The question of steam and power production, particularly with reference to the fullest possible utilization of waste heat, has also received attention. Work on the following programme has already commenced : (1) the investigation of the present methods of working to discover possible defects and advise remedies ; (2) carrying out improvements and training the firing personnel ; (3) the introduction of some practical system of control, and the undertaking of permanent supervision of firing plants ; (4) cooperation in research work for improvements in potteries.

The general impression gained after examining 16 annular kilns in different works was that (1) the firing period was too long ; (2) the fuel consumption too high ; (3) firing results irregular and (4) there was always more or less spoiled ware. The trouble in almost every case was due to the fact that too much was expected of the intelligence and capabilities of the men in charge of the plants. It is pointed out, however, with emphasis, that the defects were almost always capable of adjustment by quite simple means. In one case the firing period was reduced without difficulty from 32 to 24 hours, and on the whole, the chemical constitution of the flame was kept under control during the oxidation and reducing periods.

ON THE APPLICATION OF GENERATOR GAS-FIRING TO THE CERAMIC INDUSTRY.—K. Teichmann (*Ber. D. K. Ges.* **1**, (3) 32, 1920). The paper opens with a reference to the Spa Agreement, as a result of which

good quality coal will not be available in anything like sufficient quantity for some years. A general account of the gasification process is followed by a discussion of the conditions applying to the use of low-grade brown coal. Four different zones are recognised in the gasification process: (1) the dry zone, in which the hygroscopic water is driven off, only to dilute the gas unnecessarily in the form of vapour; (2) the first gasification zone, in which the chemically combined water is removed and the bituminous matter decomposed into tar and gas; the oxygen content in the fuel combines with carbon to give CO or CO_2, and also with H to form water vapour; (3) the second gasification zone, in which the latter process is continued, the combined oxygen in the fuel being replaced by the air blown through the grate; the CO_2 is reduced to CO in this zone also; (4) the zone of combination, where the carbon of the fuel is burned to form CO_2, thus producing the necessary quantity of heat for the generator. Generator gas is a mixture of CO_2(8—3·5%), CO(23—32%), H(8—13%), Methane (0·5—2·5%), N(50—60%). Traces of sulphur-containing gases are also present. With a low-grade brown coal of about 2000 cal. and a moisture content of about 60%, it is possible to obtain a gas in practice with an average yield of 1100 cal. At 0°*C.* and *free of moisture* the gas contains 8% CO_2, 23% CO, 11% H, 1·4% methane, and 56·6% N. From the analyses of the coal and gas, it is calculated that 1 kg. coal yields 1·5 cu. m. of gas, so that from 1 kg. of fuel with 2000 cal. 1·5 cu. m. of gas with a total of 1,650 cal. are produced, corresponding to a generator efficiency of 80%. But in practice, these conditions are never possible; in addition to the 1·5 cu. m. of gas, 0·75 cu. m. of water vapour are also produced, which dilute the gas and reduce its value. Curves are given showing the water vapour content and calorific value as functions of temperature. Below a temperature of about 72°—the condensation point—the gas becomes saturated with moisture, the percentage decreasing as the temperature falls. But even at −20°, 1 cu. m. of gas may contain 1 gr. of water vapour. The attainable flame temperature also depends upon the extent to which the gas has been dried by cooling. With the crude gas, a combustion temp. of 1,400° can be attained theoretically, but after cooling to 30° and getting rid of most of the troublesome water ballast, the temp. attainable rises to 1,800°. Another important factor in gas firing is the necessity of using as little excess air as possible. With a gas dried at 30°, the maximum temperature reached with the theoretical minimum of air is 1,800°; this is reduced to 1,400° with 50% excess of air. With a modern plant it is possible to fire with from 10 to 25% excess of air, which would give a flame temperature of not quite 1,600° using dried brown-coal gas. Taking the average kiln efficiency factor as about 0·7, we arrive at a probable oven temperature of 1,100°, corresponding to cone 1a, which is insufficient for ceramic purposes. The writer holds, however, that with the recuperative system, by means of which the air of combustion can easily be pre-heated to 300 or 400°, the kiln temp. can be brought to cones 15 or 16, even when the various factors are given minimum values. Gas-firing can therefore be satisfactorily applied to pottery kilns, provided that the gas is previously dried and the air pre-heated. In drying the gas by water cooling, not only the water vapour, but also tar vapour condenses below a certain temperature, so that the condensate consists of a mixture of water and tar. Owing to their almost equal specific gravities, these two components are difficult to separate. The best method is to pass the gas first through tar (obtained in the plant itself) at a temperature above the water-condensation point of the gas. Since tar has a greater affinity for tar than for water, this method undoubtedly gives a better separation of the tar vapours. The gas, which still contains the water vapour, is then passed through a water cooling tower. The writer calculates that the profits derived from one year's sale of the good-quality tar produced by this system, using low-grade brown coal from Saxony, are sufficient to pay for the whole of the initial cost of installation. A few details of the Mendheim gas chamber kiln are given.

TUNNEL KILN.—Dressler Tunnel Ovens Ltd. (*Pat. J.*, 1,665, 1920). No. 151,722, June 27, 1919. Combustion chambers, arranged longitudinally, but out of communication with the kiln chamber, are formed as heat accumulators. After an accumulator has been heated up, it can be put into direct communication with the kiln. Two brick-filled accumulators are arranged one on each side of the tunnel and each has communication with a source of gas supply and with an exhaust flue.

FIRING CHINA AND EARTHENWARE.—H. J. Johnson (*Pat. J.*, 1,655, 1920). No. 151,835, Oct. 24, 1919. In order to obtain upright and straight bungs of ware during firing, the sand is bedded or moulded by an apparatus having grooves for the sand.

CONTINUOUS GAS-FIRED KILNS.—C. F. Priest (*Pat. J.*, 1,667, 1920). No. 152,509, Oct. 6, 1919. Flues in the division walls between the chambers serve both as air-supply and as waste-gas flues. Each flue is provided with man-holes with covers, which are removed when the flue is supplying air; at the same time, the damper, through which the flue communicates with a longitudinal flue leading to the chimney, is closed. Gas from a main surrounding the kiln is supplied to branches, which are connected by passages to the openings. The operation of a group of 7 chambers is described.

TUNNEL KILNS.—R. C. Metcalfe (*Pat. J.*, 1,663, 1920). No. 151,217, Mar. 25, 1920. In tunnel kilns with longitudinal combustion chambers formed in sections, overlapping ribs on the sections have their corresponding faces inclined to the axis of the chamber and are of sufficient length to avoid opening of the joints under temperature variations.

GAS PRODUCERS.—O. E. Yeo (*Pat. J.*, 1,664, 1920). No. 151,445, Aug. 21, 1919. Description of a producer for the continuous generation of water-gas and producer gas, with or without coal-gas.

DISCHARGING DEVICE FOR LIME KILNS, ETC.—J. W. Teale (*Pat. J.*, 1,664, 1920). No. 151,447, Aug. 23, 1919.

BRICK KILNS.—T. West (*Pat. J.*, 1,665, 1920). No. 151,709, June 26, 1919. A kiln chamber is divided into 5 compartments and provided with flues, whereby part of the hot gases is returned from the central compartment (nearest the chimney outlet) to the intermediate and outer compartments, and, in the case of a series kiln, to compartments of an adjacent chamber. The gases from the fire-places pass downwards in the outer compartments, upwards in the intermediate compartments, and downwards again in the central portion. Heated air is supplied above each fire place for "salting" purposes by tubes of double U shape.

FURNACE GRATES.—H. C. Mann (*Pat. J.*, 1,661, 1920). No. 150,454, June 11, 1919. Transverse fire-bars having holes adapted to form conduits for the passage of air under pressure to the furnace are provided with one series of holes delivering air direct to the fuel bed and another series communicating with a chamber in the fire bridge.

TUNNEL KILNS.—C. Whitfield (*Pat. J.*, 1,661, 1920). No. 150,482, July 2, 1919. In a kiln of the Dressler type, air is delivered to the end of the combustion chamber through a passage so as to impinge on the gas admitted from below. The supply of air is preferably drawn from the interior of the kiln by the action of an injector nozzle delivering a jet of air under pressure.

ELECTRODE FURNACE.—D. Luca (*Pat. J.*, 1,661, 1920). No. 150,532, Sept. 2, 1919.

FURNACE STOKER.—J. Y. Johnson (*Pat. J.*, 1,661, 1920). No. 150,534, Sept. 4, 1919. Relates to a stepped-grate stoker.

POWDERED, LIQUID, OR GASEOUS-FUEL FURNACES.—R. J. Anderson (*Pat. J.*, 1,662, 1920). Nos. 150,761/2. In a furnace fired by liquid, gaseous or pulverulent fuel, jets of air and fuel are projected in cross-

wise relation into a closed combustion chamber, a thorough mixing and complete combustion being thereby ensured.

DRESSLER KILNS.—Dressler Tunnel Ovens Ltd. (*Pat. J.*, 1,658, 1920). No. 149,085, May 14, 1919. In cases where rapid cooling is permissible, the cooling chamber is provided with water pipes connected at the cooler end of the chamber to a header supplied with water and at the other and hotter end in communication with a steam drum. A contraction or neck of refractory material is interposed between the cooling chamber and the heating chamber. Pipes for heating air for combustion, etc., may be fitted in the cooling chamber in addition to the water pipes.

ROTARY KILNS.—J. S. Fastings (*Pat. J.*, 1,660, 1920). No. 149,764, May 17, 1919. The surface of a rotary cement kiln between the feeding end and the sintering-zone is increased by arranging rings or ribs of good heat-retaining and conducting material in or on the kiln wall, in planes at right-angles, or approximately so, to the axis of the kiln. These rings absorb heat from the gases and transmit it to the material.

ELECTRIC FURNACE.—J. R. C. August (*Pat. J.*, 1,660, 1920). No. 149,893, Oct. 18, 1919. Description of a rotary resistance furnace.

LIME KILNS.—W. Somerville (*Pat. J.*, 1,661, 1920). No. 150,157, July 23, 1919.

POWDERED-FUEL FURNACE.—E. C. R. Marks (*Pat. J.*, 1,661, 1920). No. 150,395, May 27, 1919.

CHARGING KILNS.—G. A. Collins (*Pat. J.*, 1,661, 1920). No. 150,161, July 31, 1919. In a hopper for supplying coal dust to kilns, the outlet valve, rotatable on a similarly perforated bottom plate, is secured to a tube extending up to the top of the hopper and serving not only to operate the value, but also as an observation tube.

MECHANICAL STOKER.—G. A. Revermann (*Pat. J.*, 1,661, 1920). No. 150,199, Nov. 5, 1919. In a spring-actuated, radial-shovel stoker, means are provided to vary the throw of the shovel by automatically varying the tension of the spring, and also to regulate the quantity of fuel supplied to the shovel.

MECHANICAL STOKING.—W. E. Demill & W. M. McRobert (*Pat. J.*, 1,661, 1920). No. 150,210, Dec. 2, 1919. Means are provided to vary the trajectory of the fuel.

LIME KILNS.—C. Candlot (*Pat. J.*, 1,662, 1920). No. 150,994, July 29, 1920. A device for discharging lime and similar kilns.

OIL-BURNER FOR FURNACES.—Soc. d'Utilisation des Combustibles Liquids (*Pat. J.*, 1,657, 1920). No. 148,385, July 9, 1920.

CALCINING-FURNACE.—A. V. Gowen-Lecesne (*Pat. J.*, 1,657, 1920). No. 148,497, July 10, 1920. Description of forms of furnaces adapted for the complete calcination of the raw materials in the manufacture of refractory or abrasive products from siliceous rocks, refractory clays, magnesia, dolomite, chrome-iron, spinel, agglomerated powders of emery and corundum, and zirconium and cerium earths.

MUFFLE-FURNACE.—C. F. Priest (*Pat. J.*, 1,657, 1920). No. 148,630, Apr. 26, 1919. The muffle chamber is heated by the gases from a fireplace adjacent to but not beneath it. The gases pass first through flues at the sides of the muffle, then enter the front and pass through openings in the floor.

DISCHARGING LIME-KILNS.—W. Fuchs (*Pat.* J., 1,658, 1920). No. 148,825, July 10, 1920. The discharge device of a kiln for burning lime, magnesite, cement, etc., consists of a grate to which a combined reciprocating and circular motion is given by means of cranks, eccentrics, etc.

TUNNEL KILNS.—A. Bigot (*Pat. J.*, 1,655, 1920). No. 147,391, Nov. 12, 1919. Provision is made for direct and muffle heating either alternately

or simultaneously and a number of minor improvements are included. Combustion chambers or flues are arranged in the walls of the firing-zone and communicate with similar but narrower flues in the walls of the preheating-zone, near the end of which they communicate with the chimney. When muffle heating is required the flames and gases follow this course, but for direct heating an outlet to the chimney from the interior of the tunnel is opened and the flames, etc., are then drawn from the combustion-chambers into the tunnel. The combustion chambers and pre-heating-flues may contain refractory chequer work. The inner walls are built of high refractory material and are corrugated or otherwise formed to increase radiation. The tunnel is completely closed at top, sides and bottom, as also the gas-supply flues, by insulating material such as magnesia, adapted to be airtight. Reinforced-concrete posts and beams together with intervening brick walls complete the structure. Two doors are provided at each end of the tunnel. In the cooling zone the first part is heat-insulated but the last part is built with a thin heat-conducting wall, which is either open to the atmosphere or has a jacket through which air, to be used for drying, is passed. A shortened cooling-zone is thus possible. A drier may be interposed between the waste-gas outlet and the chimney. The supports for the goods run on refractory wheels, balls, etc., and are composed of refractory and heat-insulating parts. Specification 132,069 is referred to.

RADIATION PYROMETER.—C. Zeiss (*Pat. J.*, 1,655, 1920). No. 147,482, July 8, 1920. Description of an apparatus of the bolometer type. A heat-sensitive member and a compensating member are disposed adjacent to each other in the focal plane of a reflector, by which the heat rays are collected, the heat-sensitive member being at the principal focus of the reflector. The box containing the members is rotatable round the axis of the reflector.

RADIATION PYROMETER.—C. Zeiss (*Pat. J.*, 1,655, 1920). No. 147,483, July 8, 1920. A heat-sensitive member is mounted in the focal plane of a reflector, and an auxiliary hemispherical reflector is provided in front of the member, with its centre of curvature at the focus of the reflector. The receiving surface of the sensitive member is disposed outside the axis of the reflectors.

REGENERATORS.—W. P. Thompson (*Pat. J.*, 1,653, 1920). No. 146,632, Apr. 12, 1919. An arrangement whereby heat is interchanged between fluid streams circulating parallel to one another through and around connected refractory pipes in superposed tiers.

ROTATING MUFFLE FURNACE.—J. R. C. August (*Pat. J.*, 1,653, 1920). No. 146,673, May 8, 1919. A closed-ended muffle is removably mounted in a revolvable casing on longitudinal bearers which form partitions between flues for the passage to and fro of the heating gases, the muffle rotating with the casing. When firing with liquid, gaseous or pulverulent fuel, a burner is fitted to deliver at the closed end of the casing, both the latter and the muffle being of conoidal form at the closed end.

ELECTRIC FURNACES.—P. de Miles (*Pat. J.*, 1,653, 1920). Nos. 147,014/5, July 6, 1920.

REGULATING FURNACES.—E. McLean (*Pat. J.*, 1,654, 1920). No. 147,295, Apr. 17, 1919. A description of a boiler furnace provided with a regulating device for maintaining a constant pressure in the furnace chamber. The fuel-feed is controlled in accordance with the variations in position of such regulating apparatus.

TUNNEL FURNACES.—H. Francart (*Pat. J.*, 1,680, 1921). No. 157,474, Dec. 19, 1918. In kilns in which the ware is heated out of contact with the combustion products, the heating flues are formed in hollow flanges projecting from the walls. The flues may be connected together in a variety of ways.

TUNNEL KILNS.—H. Francart (*Pat. J.*, 1,680, 1921). No. 157,475, Dec. 19, 1918. Ribs or flanges are provided on the inner walls, forming vertical or inclined recesses. The burners are fitted at the bottoms of the recesses, and the ribs may have openings in them, putting the recesses in communication with one another.

TUNNEL KILNS.—R. C. Metcalfe (*Pat. J.*, 1,682, 1921). No. 158,499, Sept. 16, 1920. A continuous tunnel kiln is made in several sections meeting at an angle, in order to economise space, and turntables are provided at the junctions.

GAS-FIRED KILN.—J. H. Marlow (*Pat. J.*, 1,673, 1921). No. 155,190. July 30, 1920. The kiln has two combustion chambers at each side, with a separate air-supply for each. Gas enters one combustion chamber, outside the oven wall, by a dampered opening. Air for combustion is supplied by pipes, and the flames pass into a second combustion chamber and thence to burners or orifices of varying sizes opening upwards from a passage, the floor of which is stepped. At a predetermined temperature, the air supply is cut off. Gas then passes to the second combustion chamber and burns with intensely heated air.

FURNACE STRUCTURES.—J. H. Cumpsty (*Pat. J.*, 1,674, 1921). No. 155,315, June 20, 1919. A refractory furnace structure or lining is made monolithic and composed of a metal reinforcement set in a cement of magnesia and silicate of soda or equivalent silicate as binding material, mixed if desired with lumps of old magnesite bricks or broken magnesite.

ROTARY FURNACES.—F. Derneden (*Pat. J.*, 1,678, 1921). No. 156,835, June, 26, 1919. To prolong the time of passage of material through rotary furnaces for roasting, calcining, drying, etc., a series of channels or chambers is arranged round the axis of rotation with connecting passages between them. The material passes from one chamber to the next during a complete revolution of the furnace, the connecting passages between the cylinders being arranged so as gradually to advance the material along the kiln during its transfer between the chambers.

CALCINING FURNACE.—A Bigot (*Pat. J.*, 1,667, 1920). No. 152,602, Oct. 8, 1920. An apparatus for calcining, baking, etc., applicable also for cooling materials, comprises a heat-insulated chamber having hollow-walls loosely packed with masses of heat-absorbing materials such as bricks, through which, as also through the chamber itself, hot or cold gases are caused to flow. The invention is applicable for drying clays, etc., dehydrating gypsum, treating bicarbonate of soda and silico-limestones, and calcining gypsum.

DISCHARGING SHAFT FURNACES.—F. W. Bakema (*Pat. J.*, 1,672, 1921). No. 154,510, May 8, 1920. Materials are discharged from a shaft furnace for the manufacture of Portland cement by a rotary helical grate.

CARRIERS FOR TUNNEL KILNS.—R. C. Metcalfe (*Pat. J.*, 1,673, 1921). No. 155,164, Apr. 7, 1920. A single reciprocating goods-carrier transports the ware between the high-temperature zone and a combined ingress and egress port situated longitudinally of the kiln from the high-temp. zone. Goods passed through either of the ports on to the reciprocating carrier, are carried by it to the centre of the kiln and then back to the same port for removal.

ENGINEERS FOR FIRING TECHNIQUE IN THE CERAMIC INDUSTRY.—R. Clauss (*Tonind. Ztg.*, **44**, 787, 1920). Scientific investigation into methods of firing, a subject which has received little attention since Seger, opens up a wide and remunerative field of activity for the firing specialist. The writer contrasts the position in the highly developed cement industry with the present state of the brick-making industry.

GERMAN VERSUS BOHEMIAN BROWN COAL.—H. Ernst (*Tonind. Ztg.*, **44**, 796, 1920). German brown coal, with the exception of Bavarian qualities, has a lower calorific value than the Bohemian. The writer indicates how the German varieties may be used.

DISSIPATOR CHIMNEYS.—(*Tonind. Ztg.*, **44**, 855, 1920). The "dissipator" is formed by the upper section of the chimney, which is built of conically perforated bricks. The object of this perforated upper section is to dilute the gases as much as possible with air, so that the smoke and gases leave the chimney in a thin, hazy cloud instead of in a compact stream.

ON SAVING COAL.—W. Engelhardt (*Tonind. Ztg.*, **44**, 877, 1920). A few general hints, dealing chiefly with the draught question.

HEAT-SAVING ARRANGEMENT OF REVOLVING TUBULAR KILNS.—E. Schott (*Tonind. Ztg.*, **44**, 781, 1920). The problem of rendering the revolving tubular kiln a more economical fuel consumer is merely a question of the utilization of waste gases. The gases from a 24 metre kiln enter the boiler at about 1000°C., give up their heat to the water and pass out at a temperature of about 250 to 300°C. The writer claims that the short tubular kiln, by utilizing the hot waste gases to generate steam and the warm (300°) gases for drying the raw materials, is far superior to any other type of kiln. The flue dust constitutes the main difficulty in utilising the waste heat for generating steam. The author's solution of this problem is a combined rotary-grate revolving-tubular kiln, a sketch of which is given on page 817.

ZIGZAG KILNS.—Anon (*Tonind. Ztg.*, **43**, 786, 1919). An article pointing out the advantages of the zigzag as compared with the ordinary Hoffmann kiln.

STEAM-JET OR UNDER-GRATE BLASTS?—(*Tonind. Ztg.*, **43**, 843, 1919). A reply from the German Evaporator Co. to Schott's article on page 464 of the journal (see page 18). The view is put forward that a steam-jet blast is preferable for all dry fuels because it is simpler and cheaper. For fuels which can be burned with a dry under-grate blast, the choice of the type of blast is purely a question of which is the most economical, but steam-jets are usually given the preference. In any case, they tend to preserve the grate bars.

THE IMPORTANCE OF DRAUGHT GAUGES.—A. H. (*Tonind. Ztg.*, **43**, 898, 1919). To ensure economical working of annular kilns, the fires must be charged with the requisite quantity of fuel at regular intervals, and the amount of air admitted must be controlled. Too little air leads to the formation of CO, with consequent loss of heat, and too much cold air lowers the temperature unnecessarily. The draught must therefore be regulated to obtain complete combustion. Illustrations are given of a portable and a stationary gauge.

NOTES ON THE FIRING OF HOFFMANN KILNS.—W. Matthes (*Tonind. Ztg.*, **43**, 1124, 1919). The stoking period must depend upon: (1) the method of placing; (2) the nature of the fuel; (3) the sensitiveness of the ware to draught; (4) the draught conditions of the kiln; and (5) variations in the firing conditions. With regard to the last item, the writer points out, that the fireman must not necessarily be required to work strictly to the readings of an automatic draught recorder. Changes in the atmospheric conditions during the night, for instance, may justify the fireman in varying his stoking periods to some extent.

DESIGN OF OPEN HEARTH FURNACES.—A. D. Williams (*Iron Age*, **105**, 35, 119, 1920). The flow of gases in a furnace is entirely devoid of mystery, being governed by the laws of elementary physics. The physical laws of flowing fluids are found to agree very closely with practical observations; they explain with remarkable clarity some mysterious troubles.

Professor Groume-Grjimailo conducted numerous experiments with model furnaces. He simulated the flow of the gases and the effects of the atmosphere by immersing his models in water and circulating coloured kerosene oil through them, the models being built with glass sides to permit observations.

In designing an open hearth furnace, the first point to be settled is the size of the hearth for the furnace. Molten metal weighs 430 lbs. per cu. ft., so that 5·23 cu. ft. of bath will be required per ton of metal capacity. The depth of bath permissible depends upon the work to be done. With a shallow

bath the reactions will be completed faster than in a deep bath. The boil will be more violent and the depth allowed for the molten cinder will be greater.

In the pig and ore process the boil will increase the volume of the bath to from 2 to 2·5 volumes. In the scrap process the bath may boil to 1·5 to 1·7 its original volume. The following table gives the approximate hearth area in square feet required for both depths ranging from 1 to 3 ft. It is computed by the formula : $3\ V\ d = A$, when V = volume of molten metal in charge, d = depth of bath, metal only, A = area of hearth.

Capacity of furnace. Tons	Cu. ft. of molten metal	Depth of bath of molten metal in inches.								
		12	15	18	21	24	27	30	33	36
		(Hearth area in sq. ft.)								
15	78·45	235	188	157	135	118	—	—	—	—
20	104·60	314	252	212	180	157	139	—	—	—
30	156·90	471	376	314	270	235	209	189	—	—
40	209·20	628	504	420	360	314	278	256	229	209
50	261·50	785	629	525	450	392	350	325	286	262
60	313·80	941	755	629	542	471	418	377	343	314
75	392·25	1177	940	785	674	588	523	470	429	392
90	470·70	1412	1130	945	812	706	628	567	515	471
100	523·00	1569	1255	1050	900	785	697	629	573	523

Allow from 3 to 6 in. for cinder and boil.

While it is necessary to provide additional depth to cover the depth of cinder and the boiling of the charge, additional area is not required for these purposes.

The temperature of the metal in the bath is between 1525 and 1600°C. The cinder will be slightly hotter than the metal, the difference ranging from a few degrees just previous to tapping, to 100 dg. or more. The gases leaving the hearth will range between 1600 to 1700°C. Told states that the gases should remain in the hearth 2 seconds ; Groume-Grjimailo that the temperature drop through the hearth should be assumed as 200°C. per sec. The theoretical flame temperature of a very good producer gas with both the air and the gas preheated to 1000° and 40% excess air, will be between 2100 and 2140°C.

These data would seem consistent. It requires between one and two seconds for the reaction of combustion to be completed, as the large jets of air and gas must be given time to mix. With too short a furnace the flame will extend beyond the hearth. With too long a furnace the gases of combustion will tend to drop below the bath temperature.

There are three limitations to the width of a furnace :

$$h = \frac{v^2 \sin^2 a}{2g} \times \frac{p_m}{p_i - p_m}$$

Developed and simplified, this formula becomes :

$$h = \frac{v^2 \sin^2 a}{2g} \times \frac{273 + t_i}{t_m - t_i}$$

For a vertical jet, or when $a = 90$ deg.:

$$h = \frac{v^2}{2g} \times \frac{273 + t_i}{t_m - t_i}$$

in which—

t_m = temperature in degrees centigrade of the gas in motion.
t_i = temperature of the gas at rest.

In the open hearth furnace, the ports are just below the roof, and the hearth forms a pocket below the level of the port and door sills. This pocket will become filled with the coolest gases in the chamber. It was found by

experience that the flame might be jetted into this pocket by the direction of the ports and the velocity of the gas and air. In European furnaces these velocities range between 12 and 18 metres per second, while in American furnaces it is as high as 50 metres per second.

If the jet theory is true, all open hearth furnaces in operation will conform to it. The air and gas entering the heating chamber of the furnace are preheated to a temperature of between 1000 and 1200°C. The theoretical flame temperature under these conditions is between 2100 and 2200°C., but the Wanner pyrometer indicates a temperature of 1800 to 1850°C. for the jet of flame. Knowing the quantity of fuel transformed into gas in the producer, it is not difficult to approximate the volume of gas supplied and the amount of air necessary for its combustion. From these data the velocity of the gas and air issuing from the ports may be computed. For example, a 30-ton furnace making four heats a day, consumes 0·347 kg. of coal per second. At zero temperature and 760 mm. atmospheric pressure, this corresponds to 1·81 cu. m. of gas and 2·52 cu. m. of air per second. At a temperature of 1000°C. the volumes of gas and air entering the heating chamber will be 8·44 cu. m. and 11·77 cu. m. respectively. The combination of gas and air gives a temperature of 1850°C. to the jet of flame.

Those experienced with the starting up of a furnace are familiar with the fact that when a furnace is cool, the flame bathes the roof, and that it drops lower and lower as the temperature in the furnace increases. A basic bottom cannot be thoroughly burnt in unless the temperature is 1600 to 1700°C.

In the following table, Professor Yesmann's formula is applied to a number of 30-ton furnaces to obtain the velocities given in columns 2 and 4. Columns 7 and 8 give the resultant angles and flame velocities. The last column shows the minimum temperature of the gases in the heating chamber at which the jet of flame will lick the bottom.

YESMANN FORMULA APPLIED TO 30-TON FURNACES.

Area of gas port Sq. M.	Velocity of gas at 1000 deg. V_g. M./Sec.	Area of Air port Sq. M.	Velocity of air at 1000 deg. V_a. M. Sec.	Inclination of gas port A_g. Deg.	Inclination of air port A_a. Deg.	Resultant angle of A_g. & A_a. Deg.	Resultant velocity of V_g. & V_a. M./Sec.	Distance of tapping notchbelow port sill. Mm.	Min tem im
0·285	29·6	0·54	21·8	15	38	27	24·0	1150	
0·358	23·5	0·57	20·6	13	40	29	21·2	980	
0·440	18·9	0·72	16·3	33	33	33	17·3	980	
0·260	32·4	0·56	21·0	10	38	25	24·5	1020	
0·320	26·3	0·64	18·4	15	41	29	21·0	1370	1

When the velocities and inclinations of the two jets forming the flame are different their resultant must be obtained by the parallelogram of velocities, in which the velocities of the air and the gas are multiplied by coefficients proportional to their weight and temperature. This resultant is then used in Yesmann's formula to determine h, or the minimum temperature at which the flame will reach the bottom of the furnace.

In these 30-ton furnaces, it is evident that the heads give a velocity and slope to the flame which bring it down to the bottom very quickly, while other parts of the furnace are still at a low temperature. This is very useful when making bottom or patching, but has disadvantages when melting and refining.

Two American 60-ton furnaces are discussed. The hearths are long, the heads show a very slight slope, and the velocity of the air is low while that of the gas is high. At a temperature of 1000° the volume of the air and gas supplies is 23·54 and 16·88 cu.m. respectively. The following is the data regarding the ports and the temperatures at which the jet of flame commences to lick the bottom :

Two 60-ton American Furnaces analysed.

	No. 1	No. 2
Area of gas port sq. m.	0·7300	0·3935
Velocity of gas in port, m. per sec.	23·70	42·90
Area of air port, sq. m.	2·70	3·75
Velocity of air in port, m. per sec.	6·20	6·28
Inclination of gas port, deg.	6	12
Inclination of air port, deg.	17	26
Drop of flame = difference in elevation between port sill and tapping notch	0·920	1·000
Resultant velocity of flame, m. per sec. ..	11·80	20·50
Resultant slope or flame angle, deg.	9·5	14·5
Temperature at which flame commences to lick bottom of furnace, deg. C.	1530	646

This shows that the cintering of the bottom in Furnace No. 1 would be extremely difficult. It is very possible that the published details of this furnace are incorrect.

There should be no difficulty, however, with Furnace No. 2 in the making of the bottom and the flame impinging upon the surface of the bath would not be reflected back against the roof of the furnace. When this furnace is in operation, erosion will occur in the gas port, but, by calculation, it can be shown that this erosion may be allowed to proceed until the gas port is 2·2 times its original section before the decreased velocity of the gas will begin to interfere with the patching of the bottom.

One of the basic principles of furnace design is : The flame must lick the hearth or bottom of the furnace. The gas pressure in the heating chamber must be equal to the atmospheric pressure. This means that a nice balance must be kept between the volume of the gas and air entering the chamber and gases removed from the chamber. When the pressure in the furnace is permitted to drop below the atmospheric pressure, cold air will tend to flow into the furnace through all cracks and openings. This chills the bath and causes excessive oxidisation. When the pressure in the furnace gets higher than the atmosphere a sharp sting of flame is developed and fuel must be burned to maintain it. In some cases, it is necessary to maintain this sting owing to the defective design of the furnace. There is no question that this method of working prevents cold air being drawn into the furnace ; it is "the easiest way." Where fuel is expensive, however, the technical control of the furnace is more closely maintained.

In order to direct the flame so that it will lick the hearth, the air and gas ports must be given a suitable inclination toward the hearth and the velocity of the flame must be sufficient to carry it down to the bottom. The velocity given to the jet of air entering the furnace is fixed by the height from the bottom of the regenerators to the port, and by the area of the port and the flues leading to it. In the case of the gas, a slightly higher head is available as it enters the regenerator under pressure from the producer.

The inclination of the ports is fixed when building the heads. It frequently happens that these heads are changed several times before they work in a satisfactory manner.

The following formula gives the height of an inclined jet of water :

$$h = \frac{v^2 \sin^2 a}{2g}$$

in which a = angle of projection, h = height jet rises, v = initial velocity of jet, g = gravitational constant.

When this is applied to a jet of flame, that is to say, a light fluid in motion in a heavier fluid, the parabola must be inverted. The force acting upon the jet is not its weight, in a downward direction, but the difference in weight between equal volumes of the fluid in motion and the medium through which it passes. The resultant force acts in an upward direction, and the jet des-

Professor Groume-Grjimailo gives the following table of furnace dimensions:

	SCRAP PROCESS				ORE PROCESS				
Capacity Tons	Length ft.	Width ft.	Area sq. ft.	Height above bath ft.	Length ft.	Width ft.	Area sq. ft.	Height above bath ft.	Heating chamber cu. ft.
15	21·32	8·52	181·7	5·25	22·57	9·57	215·3	4·43	954
20	23·45	9·18	215·3	5·91	24·61	10·33	254·0	5·00	1271
25	26·25	9·84	258·4	6·15	27·05	11·07	304·6	5·21	1581
30	27·89	10·50	290·6	6·56	29·20	11·81	344·5	5·53	1907
40	31·00	11·48	355·2	7·56	32·41	12·89	417·7	6·09	2543
50	34·45	12·46	430·6	7·15	35·96	13·98	502·7	6·32	3178
60	36·75	13·12	484·4	7·87	38·39	14·76	566·2	6·73	3814

Furnace hearths show a certain consistency in their design, a larger hearth and a shallower bath being suggested for the ore process than for the scrap process.

cribes an inverted parabola.

Professor Yesmann gives the following expression for an infinitely thin jet projected from the port of an open hearth furnace:

Let: v = initial velocity of the fluid in motion.

p_m = specific weight ,, ,, ,,
p_i = ,, ,, ,, ,, at rest.

The weight of each unit of volume of the fluid in motion being less than p_i, the ascensional force which acts upon each unit of volume is equal to $p_i - p_m$. The acceleration caused by this force is:

$$\frac{p_i - p_m}{p_m} = g$$

The depression of the jet for this condition is: 1. The distance material can be thrown through the door by expert manipulation of a shovel; 2. The width the flame can spread; 3. The limitation due to the strength of the roof.

The following table shows the maximum and minimum hearth dimensions of a number of furnaces in service.

ty ns.	Length, ft.		Width, ft.		Area Sq. ft.		L/W		A/Ton.		3 V/A	
	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
	13·50	19·25	6·50	7·54	101·0	163·6	1·82	2·96	10·12	16·36	0·96	1·55
	19·67	22·37	8·52	9·83	181·0	215·0	2·00	2·50	12·06	14·35	1·10	1·31
	20·00	24·61	9·18	10·50	210·0	254·0	1·92	2·56	10·50	12·70	1·24	1·50
	25·00	27·87	9·84	12·00	262·5	304·6	2·08	2·67	10·30	12·20	1·29	1·52
	21·00	29·20	9·30	12·50	195·0	344·5	1·77	2·70	8·93	11·40	1·36	2·41
	21·87	24·00	12·00	12·25	267·0	288·0	1·79	2·00	7·62	8·20	1·92	2·06
	24·00	32·41	11·00	12·89	264·0	417·7	2·00	2·70	6·60	10·50	1·51	2·38
	26·75	35·96	10·00	15·00	287·0	502·7	1·95	3·20	5·74	10·00	1·56	2·74
	29·00	43·00	11·80	16·75	387·0	720·0	1·94	2·80	6·45	12·00	1·30	2·43
	34·00	40·00	13·50	16·00	460·0	640·0	2·50	2·53	6·14	8·53	1·84	2·56
	—	39·50	—	15·25	—	600·0	—	2·56	—	6·67	—	2·36

A WAR-TIME LIME KILN.—W. Hänse (*Tonind. Ztg.*, **44**, 717, 1920). The writer describes how a kiln was constructed to supply quick-lime at short notice in the vicinity of Verdun, in 1915.

REFRACTORY AND PROTECTIVE COATING ON FURNACE LININGS.—E. R. Stowell (*U.S. Pat.*, 1,350,343, 1920). A suitable compound is prepared by adding 8 lbs. of powdered SiC to each gallon of a 4% solution of NaOH in water, and allowing the mixture to stand in a covered container until all the hydrogen is cooled. The foamy compound thus obtained is stirred until reduced to its original volume, 1 pint of a sodium silicate solution of 50—54% Bé being then added to each gallon of the compound.

LIQUID FUEL FOR STEAM BOILERS.—Ingold (*Deut. Töp. Zieg. Ztg.*, **50**, 333, 1919). The advantages of firing with liquid fuel, apart from the coal shortage, are: (1) complete combustion and utilization of the heat; (2) No smoke or soot; (3) no losses due to slag and unburnt fuel; (4) simple starting and rapid attainment of the maximum temperature; (5) little attention necessary; (6) diminished expenses for repairs; (7) better storage posibilities for fuel; (8) no loss or deterioration of fuel due to storage; (9) higher calorific value for equal weight and consequent reduction of freight expenses.

FIRING TEMPERATURES ATTAINABLE WITH WOOD.—H. Sachse (*Tonind. Ztg.*, **44**, 709, 723, 1920). Perfectly dry wood has the following average chemical composition: 58% carbon, 6% hydrogen, 34% oxygen, 2% ash. Owing to the presence of oxygen in the wood, the hydrogen content is only partially available for the development of heat on burning, the proportion corresponding to the formula $H-\frac{O}{8}$ where H is the hydrogen and O the oxygen content of the wood. The wood, therefore contains only $6-\frac{34}{8}=1{\cdot}75\%$ of combustible hydrogen, the remaining 4·25% being combined with the 34 parts of oxygen in organic compounds. For the purpose of thermal calculations, these compounds may be considered equivalent to 38·25% of chemically combined water, and, as such, do not aid in the evolution of heat. On the contrary, heat is consumed in vaporising this water. The calorific value of wood is therefore represented by the amount of heat liberated on the combustion of the carbon and of the combustible hydrogen, less the quantity of heat required to vapourise the chemically combined water. If C = the carbon content, H = the hydrogen content and O = the oxygen content of the wood, so that $H-\frac{O}{8}$ = the amount of combustible hydrogen, and $\frac{O}{8}$ the amount of chemically combined water present, then the calorific value = $[8000 . C + 29{,}000 . (H-\frac{O}{8}) - 600 . \frac{9}{8} 0] . 0{\cdot}01 = [8000 . 58 + 29{,}000 . 1{\cdot}75 - 600 . 38.25] . 0 . 01 = [464000 + 50750 - 22950] . 0{\cdot}01 = 4918$ cal. For the complete combustion of 1 kg. of dry wood it is calculated that 7·272 kg. of air are required. The flame gases from 1 kg. wood consist of 2·127 kg. CO_2, 0·1575 kg. H_2O (from the combustible H.) + 0·3825 kg. H_2O (from the chemically combined water already in the wood) = 0·54 kg. H_2O in all, and 5·585 kg. N. Assuming that the theoretical flame temperature would be approx. 2000°C., the mean specific heat of 1 kg. CO_2, between 0° and t° at constant pressure, can be taken as 0·283, of the water vapour as 0·578 and of the N 0·282. The flame temperature t, can then be obtained from the equation:

$$t = \frac{4900}{2{\cdot}127 . 0{\cdot}283 + 0{\cdot}540 . 0{\cdot}578 + 5{\cdot}585 . 0{\cdot}282}$$

$$= \frac{4900}{0{\cdot}601941 + 0{\cdot}312120 + 1{\cdot}574970}$$

$$= \frac{4900}{2{\cdot}489031} \sim \frac{4900}{2{\cdot}5} = 1960^{\circ}\text{C}$$

Owing to loss of heat through radiation, etc., the actual temperature reached in practice is approximately 1450°C. By similar methods of calculation, the writer shows that air-dried wood, containing 20% of hygroscopic water, has an approximate calorific value of 3800 cal., and a theoretical flame temperature of 1825°C. In practice, this is reduced to 900—1000°C. The calorific value of green wood is approximately 2160 cal. and the theoretical flame temperature round about 1500°C.; but with the large excess of air necessary for complete combustion, this is reduced to about 900°C. In practice, the temperature attainable with green wood does not exceed 700°C., so that a glost fire is impossible.

COAL-SAVING METHOD OF FIRING ANNULAR KILNS.—P. Thor (*Deut. Töp. Zieg. Ztg.*, **50**, 247, 1919). A general résumé of the subject, giving indications of the method of utilising automatic draught records, etc.

REFRACTORY LINING FOR CUPOLA FURNACES.—H. Geyer (*Tonind. Ztg.*, **43**, 1289, 1919). A short, general survey of the subject.

THE ANNULAR KILN FIREMAN.—M. Grimm (*Deut. Töp. Zieg. Ztg.*, **50**, 141, 1919). It is essential for satisfactory and economic working of the kilns, that the fireman should keep pace, as far as possible, with the latest developments in kiln technique. He should also be thoroughly acquainted with several systems of kilns, and should have a very clear idea of what takes place in the smoking and firing processes. A common mistake on the part of the men, is to make the stoking period too long, and the quantity of fuel

charged too great. To obtain the best results, the men should be trained to work both to a kiln thermometer and a draught recorder.

FUEL-CONSUMPTION IN ANNULAR KILNS.—K. Dümmler (*Deut. Töp. Zieg. Ztg.*, **50**, 355, 1919). By a simple calculation, the writer shows that the volume of air required for the complete combustion of the necessary quantity of fuel is only a small fraction of the total volume of air required to transmit the heat from the fired to the unfired bricks. The greater proportion of the heat produced in annular kilns is required to meet heat losses by radiation from the kiln walls, to bring about the chemical reactions in the bricks during the burning process, to drive off the moisture in the bricks, and, above all, to produce the necessary draught conditions. The large volume of air necessary to transmit the heat to the unburned ware can be regulated much more easily by means of artificial draught apparatus than by the usual chimney construction. To save fuel, the draught must be as strong as possible, so that the necessary large volume of air may be passed through the firing chamber. But for this purpose, only air which has been sufficiently pre-heated by passing over fired ware must be used.

THE FIRED COLOUR OF LIME-CONTAINING CLAYS.—Loeser (*Deut. Töp. Zieg. Ztg.*, **50**, 343, 1919). Calcium carbonate occurs in clays in various forms, varying in size from the finest powder to large pebbles. Clays containing calcium carbonate in a finely divided condition, even up to 35% of the dry material, are not necessarily unsuited for brick making, though there is often too much free CaO present in the fired ware. This free CaO absorbs moisture from the air and is converted into $Ca(OH)_2$ so that the brick becomes useless after a short time. In general, clays which fire a light, yellowish colour at ordinary brick-burning temperatures (cone 010) show comparatively small variations in shrinkage between that and the melting temperature, between cones 01a and 1a. In other words, the density does not increase in proportion to the rising temperature. In general, firing temperatures higher than cone 010a to 08a (900°—940°C.) are not required for lime-containing clays. The analysis of these clays shows a high percentage of iron oxide, which would lead one to expect a distinctly red colour in the burned bricks. But the lime destroys the red colour of the iron oxide, the light coloured calcium-iron-aluminium silicate being formed. The lime-containing clays are good indicators of the uneven effect of the fire in annular kilns. In the same kiln, the colour of the bricks may vary from red to yellow, and even green where melting has occurred. The over-fired ware will come out yellow, with traces of melting.

THE BLAST-FURNACE HEARTH.—W. Mathesius (*Chem. Met., Eng.*, **23**, 867, 1920). A wide hearth permits steeper bosh and flatter stack lines with many resulting economies. Operating data, construction details and theoretical considerations point to its definite superiority. Several sketches are given, and two tables showing operating data for various blast furnaces.

THE POSSIBLE UTILIZATION OF VARIOUS FUELS AND LABOUR-SAVING DEVICES IN THE BRICK-MAKING INDUSTRY.—Baschant (*Deut. Töp. Zieg. Ztg.*, **50**, 367, 382, 1919).

THE HOFFMANN KILN AND ITS PROTOTYPE.—K. Dümmler (*Deut. Töp. Zieg. Ztg.*, **50**, 393, 1919). A discussion of the question as to whether Hoffmann worked from prototype in designing his kiln.

FIRING POTTERY UTENSILS IN ANNULAR KILNS.—T. Klein (*Deut. Töp. Zieg. Ztg.*, **50**, 514, 1919). The writer describes how he succeeded in firing the simpler forms of utensils together with glazed bricks in an annular kiln. Body and glaze for the pots were altered to suit the lower brick-firing temperature, viz.: cone 08a—06a (990—1030°C.) The placing arrangements are shown in 2 sketches. It was also found that a better quality coal was necessary for successful firing.

KILN CONTROL.—Gr. (*Deut. Töp. Zieg. Ztg.*, **50**, 526, 1919).

ZEHNER'S "REFORM"-KILN FOR SMALL WORKS.—(*Deut. Töp. Zieg. Ztg.*, **50**, 553, 1919). A short description, with illustration of the kiln, which is a simplified form of the zig-zag oven.

EFFICIENT HEATING OF PUBLIC BUILDINGS.—(*Tonwar. Ofen. Ztg.*, **43**, 18, 1919).

PEAT AS SUBSTITUTE FOR COAL.—(*Tonwar. Ofen. Ztg.*, **43**, 39, 1919).

REPORT OF A COMMISSION ON THE SMOKE AND DUST QUESTION.—(*Tonwar. Ofen. Ztg.*, **43**, 52, 1919). A short summary of a report read at the meeting of the Bavarian Polytechnic.

MEASURING THE QUANTITY OF DUST IN FLUE GASES.—(*Tonind. Ztg.*, **43**, 914, 1919). Taken from a paper by Dr. Grimm read at the meeting of the German Portland Cement Manufacturers' Association. The writer has tested the various methods at present employed for measuring the quantity of dust in flue gases, and concludes that none of them are strictly reliable. Results obtained with these different systems must be treated with the greatest caution.

UTILIZATION OF LOW-GRADE FUELS.—Anon (*Tonind. Ztg.*, **43**, 1318, 1919). A description of a special revolving "drum" burner for firing with fine brown coal. The article is illustrated.

REPAIR WORK IN THE COMBUSTION CHAMBER OF ANNULAR KILNS.—F. J. (*Deut. Töp. Zieg. Ztg.*, **50**, 50, 1919). Cracks should not be simply filled with grog mortar, as this rapidly contracts and falls away. They should be carefully cleared of all dust, ashes, etc., and filled as completely as possible with pieces of grog brick, using as little mortar as possible. Loose bricks must be taken out, cleaned, and re-set. Burned-out portions must be treated in the same way.

SILICA BRICKS IN COKE-OVEN CONSTRUCTION.—J. Enzenauer (*Stahl Eis.*, **40**, 1326, 1920). Two batteries, of 65 ovens each, were constructed at a steelworks in Duisburg, in 1915/16. The mechanical arrangements and labour-saving devices in connection therewith are first described in some detail. Photographic illustrations of the coal-mixing and coke-loading plants are given.

In spite of the extremely favourable reports from America, particularly with regard to the short coking period (16 hours), considerable doubt was at first entertained as to the advisability of resorting to silica brick construction. It was feared that the yield of ammonium sulphate would be adversely affected, that the tar would be too thick owing to the high oven temperature, etc., etc. The shorter coking period is generally held to be due to the greater volume of fuel gas admitted to the ovens, so that the bricks can absorb and radiate heat more rapidly. In addition, silica bricks have a higher thermal conductivity ; consequently, even if the temperature in the flues is approximately the same, that in the oven itself will be much higher with silica brick than with grog-brick construction. The following tables 1 and 2 are taken from P. Goerens and S. W. Gilles' work : *"On the thermal conductivity of refractory bricks."**

Table 1—CHEMICAL COMPOSITION OF THE TESTED MATERIAL.

Material	SiO_2 %	Al_2O_3 %	Fe_2O_3 %	CaO %	MgO %	Alkalies %
Semi-grog ..	73·11	22·85	1·94	0·20	0·18	1·72
Grog	67·68	28·18	1·89	0·28	0·12	1·86
Shale	53·91	40·16	1·94	0·15	0·22	1·30
Lias	53·00	45·30	1·20	trace	trace	0·50
Silica	96·04	1·82	0·68	1·46	—	—

*Mitteilungen aus dem eisenhüttentechnischen Institut der Königl. Techn. Hochschule, Aachen, **7**, 1/15, 1916.

Table 2.

Material	Sp. Gravity		Porosity %	Co-efficient of Thermal Conductivity $= \frac{Cal.}{m.h.deg.C.}$										
	Apparent	Real		0° to 100°	100° to 200°	200° to 300°	300° to 400°	400° to 500°	500° to 600°	600° to 700°	700° to 800°	800° to 900°	900° to 1000°	Average 0° to 1000°
Semi-grog ..	1·83	2·59	30	0·79	0·79	0·82	0·84	0·88	0·93	0·97	1·02	1·05	—	0·90
Grog ..	1·80	2·53	29	0·75	0·78	0·80	0·84	0·89	0·95	1·03	1·07	1·10	—	0·91
Shale ..	1·81	2·62	31	0·78	0·82	0·88	0·93	0·97	1·04	1·10	1·13	1·15	1·18	0·99
Lias	1·75	2·80	39	0·72	0·71	0·72	0·74	0·75	0·76	0·78	0·81	0·82	0·84	1·76
Silica ..	1·87	2·44	23	1·01	1·00	1·06	1·08	1·13	1·17	1·21	1·26	—	—	1·11

Battery No. I. was built of silica bricks, with lime as binder, of the following average composition: 1·6—1·9% Al_2O_3, 94·5—95% SiO_2, 1—1·5% Fe_2O_3, 1·8—2% CaO, 0·1—0·15% MgO, 0·6—0·8% alkalies. In Battery No. II. ordinary grog bricks were used, containing: 15—17% Al_2O_3, 79—81% SiO_2, and approximately 1·8% Fe_2O_3, 0·3% CaO, 0·3% MgO and 1·60% alkalies. No. I battery has now been in operation four years, and is in a much better, condition than battery No. II., which has been worked less intensively over a period of only 3 years, so that the misgivings originally entertained against the use of silica material are now shown to have been quite without foundation. The corrosive action of salt on the grog bricks was very marked; many of the walls have had to be repaired. With the silica material on the other hand, no trouble has yet been experienced. During the period when the silica brick battery was working alone, with a coking period of 24 hours, the yield of the sulphate of ammonia averaged 1·12%, that of purified benzole 0·65%. When the grog brick battery was brought into operation, the yield of ammonia was not increased, as might have been expected, whilst the supply of benzol actually dropped to 0·60%. This, however, may have been the result of variations in the quality of the coal supplied, and of irregular working of the ovens. But in any case, the quality and quantity of the gas and coke production easily outweighs the possible decrease in the yield of by-products from silica brick ovens. The tar produce was somewhat thick, containing from 2 to 3% water, but this was probably due, at least in part, to the fact that the outlets were situated rather higher than usual. The advantages of silica brick construction are summarised as follows: the coal charge and the production of coke and gas can be increased considerably; scorification, melting, and faulty walls, due to over-heating, can scarcely occur. Silica bricks are highly resistant to the action of salt and water present in the coal.

The following results were obtained from observations extending over a period of 8 days:

Table 3.—COMPARATIVE VALUES FOR SILICA AND GROG BRICK COKE OVENS.

	Silica battery	Grog battery
No. of ovens charged in 24 hrs...	65	54
Coking period	24 hrs.	29 hrs.
Coal charge (dry) per oven	7 t.	7 t.
Coal charge (wet) ,, ,, ...	7·8 t.	7·8 t.
Coal consumption (dry) per hour	18·96 t.	15·91 t.
Gas consumption per hour at O°C & 760 mm...	3580 cu. m.	2990 cu. m.
Heat consumption per kg. dry coal	692 cal.	697 cal.
Temperature in horizontal flues (gases of combustion)	1069°C.	1027°C.
Oven temperature	908°C.	804°C.
Raw gas temperature in ascending pipes ..	456°C.	434°C.
Raw gas temperature in suction pipes.. ..	275°C.	249°C.

In the following thermal tables, the item "Radiation and Conduction" is perhaps a little uncertain. The figures were obtained by the Stefan-Boltzmann formula, but they would be decreased under the endothermic distillation process and increased under the exothermic system.

Table 4.—DISTRIBUTION OF THE CALORIES SUPPLIED BY FUEL GAS.

Battery No.	Calories per kg. dry charge	Distribution of calories supplied per kg. dry charge.							
		Distillation gas		Coking		Cooling		Radiation & Conduction	
		Cal./kg.	%	Cal./kg.	%	Cal./kg.	%	Cal./kg.	%
I. ..	692	87·9	12·7	370·8	53·6	137·0	19·8	94·3	13·9
II. ..	697	85·4	12·3	320·2	45·9	123·4	17·7	165·0	24·1

Table 5.—THERMAL BALANCE SHEET.

IN-COMING.					OUT-GOING.				
	Battery I.		Battery II.			Battery I.		Battery II.	
Per kg. dry charge.	Cal.	%	Cal.	%	Per kg. dry charge	Cal.	%	Cal.	%
Gas, free calories ..	692·0	67·97	697·0	68·31	Distillation gas	87·9	8·7	85·4	8·4
In gas flues	1·26	0·12	1·23	0·12	Coking	370·8	36·5	320·2	31·5
In arch	4·35	0·43	4·39	0·43	Regenerator	268·7	26·5	276·6	27·2
Total gas	697·6	68·52	702·6	68·86	Brickwork*	34·9	3·4	24·9	2·5
Outside air	4·35	0·43	4·5	0·44	Hearth	137·0	13·5	123·4	12·2
Air in arch	11·55	1·14	10·54	1·04	Arch (gas)	4·35	0·4	4·39	0·4
Air in regenerator ..	303·60	29·91	301·50	29·66	,, (air)	11·55	1·1	10·54	1·0
Total air	319·5	31·48	316·54	31·14	Radiation & Conduction	101·9	9·9	173·73	16·8
Total	1017·1	100·00	1019·16	100·0	Total	1017·1	100·0	1019·16	100·0

* *i.e.*, of the regenerator. This figure is obtained by deducting the amount of heat given up by the products of combustion in the regenerator, from the quantity of heat absorbed by the air in the regenerator.

FIRING WITH COAL-DUST—A SOLUTION OF THE FUEL QUESTION.—C. Degelow (*Tonind. Ztg.*, **44**, 752, 767, 1920). The writer points to the great strides made in America in recent years with the problem of coal dust firing, and discusses the work carried out in this connection by L. C. Harvey, an Englishman, who has published the results of his research work in America. A clear proof of the advantages of the system is the fact that over 250 locomotives in Brazil are now driven by this method of firing, using the low-grade coal of the country, where formerly only the expensive N. American supplies could be relied upon. Trials carried out on an American patrol boat showed that equal speed could be attained with one boiler fired with powdered coal as with two oil-fired boilers.

A NEW UNDERGRATE BLOWER.—K. T. (*Tonwar. Ofen. Ztg.*, **43**, 120, 1919). The grate consists of 3 or 4 cast iron chambers, open at the top, perforated plates are fitted into the top, and air is forced into the chambers from a distributing flue below, which is connected by pipes with a fan. The latter should preferably be driven electrically.

A STANDARD STOVE.—(*Tonind. Ztg.*, **44**, 724, 1920). A description of a domestic stove designed by Prof. Brabbée of the Berlin Technical Highschool.

GLAZES, ENAMELS.

ENAMELS.—C. Musiol (*Pat. J.*, 1,642, 1920). No. 142,688, June 6, 1919. Enamels are made without boron, lead, arsenic, milk glass or opal glass, from a mixture of silicates of alumina, soda, and lime and fluorides, fused and ground, colouring matter such as metallic oxides being added during the grinding process. Carbonate of ammonia may be added if desired, and the composition so obtained is applied to articles and heated to temperatures ranging from 800 to 1050°C.

ENAMELS AND GLAZES.—E. Rietz (*Pat. J.*, 1,658, 1920). No. 148,816, July 10, 1920. White clouded glass, enamels and glazes are made by using fluorides in conjunction with compounds of zirconium, tin, beryllium, etc. Suitable compounds are alkali fluorides, alkali silico-fluorides, calcium fluoride, and cryolite. A frit, given as an example, consists of soda, felspar, quartz, natural zirconia and sodium silico-fluoride. The fluorine compounds are used in larger proportion than has hitherto been the case. The batches must contain a large proportion of silica.

A METHOD OF PREPARING A LEADLESS GLAZE.—(*Deut. Töp. Zieg. Ztg.*, **50**, 265, 1919). The process is based on the discovery that an excellent glaze can be produced simply by means of a slip, without the addition of fluxes and without polishing, provided that the slip consists of practically pure clay molecules. The absence of all impurities increases the cohesive and adhesive power of the clay molecules, so that the molecules of the slip and of the body come into close contact. A bright, glossy covering is thus obtained even in the unfired condition, and this is improved by burning at low temperatures. The inventor, C. Nuissl, who has patented the process, prepares the slip by mixing 1 kg. of clay with a large quantity of water. This thin slip is allowed to flow very slowly through wooden troughs, 4 m. long, in which the impurities settle. In using the resulting slip, no consideration need be given to the relative shrinkage of body and glaze, and this is claimed as a great advantage.

WHITE GLAZED FACE-TILES.—Hasak (*Deut. Töp. Zieg. Ztg.*, **50**, 203, 1919). A short discussion of the use of face-tiles from the architectural point of view.

THE CAUSE OF CRACKING AND SCALING OF GLAZED BRICKS.—W. Pukall. (*Deut. Töp. Zieg. Ztg.*, **50**, 256, 1919). The cracking and scaling of the glaze of bricks used for building garden walls, etc., may be caused by the crystallisation of sulphates contained in ground water, particularly near refuse or coal heaps. The glaze, like the body, is always more or less porous,

so that a certain amount of water enters the brick. The sulphates dissolved in the water crystallise out in the pores and, in time, cause cracking and scaling. This can only be avoided by using a dense body, or by isolating the bricks from the ground moisture.

COLOURS, DECORATIVE PROCESSES, ETC.

CERAMIC CHROMATOLOGY.—W. Ostwald (*Ber. D. K. Ges.* **1**, (3), 5, 1920). Monumental art is becoming more and more dependent upon ceramic materials, since they alone are able to withstand the attack of the sulphuric acid present in the atmosphere as a product of coal combustion. Sgraffito, fresco and marble consist of calcium carbonate which is attacked by H_2SO_4. Sandstone, copper and bronze are also adversely affected. The importance to makers of ceramic products of the standardization of colours in relation to monumental art is therefore apparent.

All colours are composed of the elements white, black and "full" colour, and can be represented by the equation : $f+w+b=1$, where f="full" colour, w=white and b=black. In general, all three factors have positive values, though in theory one or two may represent zero. A "white" surface is taken to be one which reflects,—a "black," one which absorbs all light. By a "full" colour is understood yellow, red, blue, green, (with all the intermediate shades) in which the tint is fully preserved without the admixture of white or black. The simplest conditions are met with in colours containing only black and white—the grays—represented by the equation : $w+b=1$. For practical purposes, 20 grades of gray may be recognised between white and black, and represented by the letters *a*, *b*, *c*....etc., *a* standing for white, and so on ; beyond *l* the gray becomes so dark as to become included under black. In practice, these grades are found to be too fine ; every other letter is therefore omitted, and we get the standard series of grays : *a*, *c*, *e*, *g*, *i*, *l*, *n*, *p*..... The proportion of white in these grades must decrease according to Fechner's Law in geometrical or logarithmetical progression. If this series is prepared in the form of a "scale" or "ladder," it becomes an easy matter to decide to which particular grade any gray surface belongs.

The "full" colours, or colours proper, also form a continuous series, but, unlike the grays, they have no definite beginning or ending. Beginning with yellow, for instance, we get orange, red, violet, ultramarine, ice-blue, sea-green, green and back to yellow, thus completing the cycle. These are the 8 principal colours which together with an indefinite number of intermediate shades, form the complete "colour cycle." For standardisation purposes, this cycle must be divided into 10 or 100 parts ; but since there are 8 natural divisions, which would be too few for practical purposes, whilst 100 sub-divisions would be too many, it has been decided to make 3 sub-divisions for each principal colour. This gives 24 standard tints which are designated first, second and third yellow, orange, red, etc. In converting these into the 100-grade cycle, breaks occur which have to be allowed for :

	1st	2nd	3rd		1st	2nd	3rd
Yellow..	00	04	08	Ultramarine ..	50	54	58
Orange	13	17	21	Ice-blue	63	67	71
Red ..	25	29	33	Sea-green ..	75	79	83
Violet ..	38	42	46	Green	88	92	96

To combine these with black and white, the writer shows how a "colour-triangle" may be constructed for each of the above tints 00 to 96, and how these 24 triangles may be arranged so as to give a general survey of all the different shades of colour. He also claims that the system enables one to determine without fail what colours will harmonize together.

DECORATING POTTERY.—F. C. A. Tuhten (*Pat. J.*, 1,650, 1920). No. 145,823, Mar. 25, 1919. Pottery, tiles, etc., are decorated by applying gold, silver or lustre in patches to the article in the glazed condition. They are then fired and a decoration applied by means of a lithographic transfer sheet

printed in metallic colours, or a combination of metallic and other colours, arranged so as to expose portions of the gold, silver or lustrous surface. The article is then fired again.

ORNAMENTING POTTERY.—A. P. Morris (*Pat. J.*, 1,674, 1921). No. 155,332, Aug. 15, 1919. Ware which has been blackened during firing by deposition of carbon is ornamented by removing parts of the carbon deposit by oxidation, thus revealing the natural colour of the clay. A paste of clay with an oxidising agent, *e.g.*, potassium chlorate, is applied in a pattern, and the article is heated to a temperature sufficient to release the oxygen, but below that at which the clay is fired. By suitable selection of the clay used in making the ware, different colourings may be produced in different parts of the figuring.

GLOST-OVEN PORCELAIN COLOURS.—W. Funk (*Ber. D.K. Ges.* 1, No. 1, 24—36, 1920). A general survey of the raw materials used and the method of preparation for the various colours. The writer deals mainly with high temperature colours for hard porcelain.

COLOURING DOLL HEADS.—Anon. (*Sprech.*, **53**, 486, 1920). The writer describes the following method of producing a good skin-colour as quite new and thoroughly reliable. The body must contain 30% felspar, as quartz bodies give a violet colour. The constituents of the body are: 31·52 parts by weight of felspar, 3·05 parts calcite, 52·87 parts kaolin, 12·56 parts quartz, 0·2 parts soda and 79 parts water. Grinding requires 80 hours, at 23 rev. per minute. Fourteen per cent. of a colouring mixture, prepared as follows, is ground with this body: 30 parts pure, crystallised manganese sulphate, dissolved in water, are poured over 100 parts pure aluminium hydroxide, and dried. This mixture is fired in a muffle oven to cone 02a, and gives a pink colour. To this, a solution in water of 10 parts ammonium phosphate is added, and when dry, it is again fritted in a muffle oven at cone 02a. The pink mixture is boiled in water containing 8% sulphuric acid, and is then ready for use. The body is fired in an *oxidising* atmosphere at cone 9. Under the action of the oxidising flame the iron gives a light yellow colour to the body, and this blends with the delicate pink to give a fine skin colour.

PLANT AND MACHINERY, ETC.

THE POTTER'S WHEEL.—Anon (*Tonind. Ztg.*, **43**, 779, 1919). A description of various machines, with illustrations.

BRICK MAKING MACHINES.—P. Piesnack (*Deut. Töp. Zieg. Ztg.*, **50**, 130, 1919). A short description of a machine made by C. Wulff, of Wriezen, which requires from 10 to 12 H.P. working at full capacity. The advantages of such a machine are: brick-makers' services can be dispensed with, one woman or girl being sufficient to serve the machine; the strength of the brick is greater than is the case with hand-made bricks; in drying, less heat is required to drive off the form-water. But the apparatus wants careful attention to avoid break-downs.

NOTES ON EDGE MILLS.—(*Tonind. Ztg.*, **44**, 488, 1920).—The runners should preferably be supported by two independent crank axles so as to ensure equal distribution of pressure. Runners supported on a single axle wear more rapidly at the outer end. The perforations in the grate should take the form of long slits running crosswise.

AUTOMATIC BRICK-CUTTERS.—K. Dümmler (*Deut. Töp. Zieg. Ztg.*, **50**, 480, 1919). A short discussion of American methods and machines.

MECHANICAL APPLIANCES IN FINE-CERAMIC WORKS.—A Sauer (*Beo. D. K. Ges.* **1**, (3) 14, 1920). The article deals mainly with mechanical arrangements for unloading and transporting raw material and ware.

BRICK MACHINES.—W. J. Todd (*Pat. J.*, 1,645, 1920). No. 143,628, Feb. 26, 1919. A description of a machine comprising means for turning.

bricks, delivered from a brick-making machine, from their flat sides on to their edges amd depositing them on a horizontal delivery table, such means consisting of a rotary drum or wheel furnished with projections, which engage beneath the bricks and, after a quarter of a revolution, deliver them on edge to the table.

MOULDING BUILDING-BLOCKS.—J. Stephenson (*Pat. J.*, 1,647, 1920). No. 144,492, July 9, 1919. A rotary-mould table machine is described.

ROLLER-AND-RING MILLS.—J. E. Kennedy (*Pat. J.*, 1,647, 1920). No. 144,723, June 11, 1920. A roller-and-ring pulveriser is interposed in a forced air circulation effected by a fan, which delivers the air carrying the ground material through a pipe to collectors.

BALL AND LIKE MILLS.—J. E. Kennedy (*Pat. J.*, 1,647, 1920). No. 144,725, June 11, 1920. Relates to tube mills which are divided into compartments by a perforated transverse partition, and particularly to means for securing the partition in position.

EXCAVATORS.—S. Templeton (*Pat. J.*, 1,669, 1921). No. 153,402, Aug. 19, 1919. A description of an excavating-appliance for attachment to power-driven cranes.

FINISHING MACHINE FOR JAM-POTS, ETC.—W. Ingam (*Pat. J.*, 1,642, 1920). No. 142,588, Feb. 28, 1919. A description of a machine which comprises an expansible mandrel and sliding tool holders or devices.

SEPARATING CRUSHED ROCK.—T. J. Sturtevant (*Pat. J.*, 1,643, 1920). No. 142,989, Apr. 9, 1919. An illustrated description of a separator for grading crushed rock, minerals, etc., comprising superposed screens carried by a removable frame provided with bridge bars, to which vibrations are imparted through pins by means of hammers.

UNLOADING RAILWAY VEHICLES.—H. Richardson (*Pat. J.*, 1,645, 1920) No. 143,558, May 20, 1920. Relates to apparatus of the kind in which the vehicle is first tilted in one direction and then in the other about a transverse axis. It is retained on the platform of a tilting-cradle by buffers.

DRIVING POTTERS' LATHES.—C. J. Robinson (*Pat. J.*, 1,661, 1920). No. 150,389, May 23, 1919. A movable frame equipped with pulleys is adapted to bring a driven belt or rope into driving contact with either of two pulleys arranged side by side and coupled to the lathe shaft.

BALL-MILLS.—J. R. Broadley (*Pat. J.*, 1,671, 1921). No. 154,434, Nov. 14, 1919. Relates to means for returning insufficiently ground material to the grinding compartment of the mill.

BRICK-CUTTING MACHINE.—W. Smith (*Pat. J.*, 1,675, 1921). No. 155,657, Sept. 25, 1919. Double guides are provided to obviate twisting of the knives.

GYRATORY CRUSHERS.—Smith Eng. Works (*Pat. J.*, 1,679, 1921). Nos. 157,137/8, Jan 8, 1921. Means are provided for enabling the position of the crushing-head in the hopper to be adjusted to compensate for wear or to alter the size of the product.

BALL MILLS.—H. W. Hardinage (*Pat. J.*, 1,662, 1920). No. 150,997, Aug. 20, 1920. Means are provided near the discharge passage to separate, the coarse from the fine particles and to return the former to the larger part of the barrel for further grinding.

JOLLIES.—J. L. Wakefield (*Pat. J.*, 1,664, 1920). No. 151,296, Mar. 11, 1919. In order that the tool may clear finished articles having projecting portions such as necks, curved feet, etc., the tool-holder is pivoted to a two-armed counter-weighted lever pivoted to a standard. It is also connected by an eccentric to a link pivoted to a fixed bracket, the link being shorter than the arm.

JOLLEYING.—C. Baggley (*Pat. J.*, 1,664, 1920). No. 151,312, May 22, 1919. In jolleying elliptical or polygonal ware, the profile is carried by a slide, which is moved horizontally by a crank through a rod, cranked lever and link, the crank being carried by a shaft driven from the jolley spindle through a change-speed gear. The movement of the profile may be further varied by means of a ring.

BALL-MILLS.—J. R. Broadley (*Pat. J.*, 1,668, 1920). No. 152,724, July 8, 1919. A modification of specification 116,583. The unfinished material is returned to the grinding-chamber by means of radial troughs or tubes.

JOLLIES.—Aktiebol. Gustafsberg-Fabriks-Inter. (A. S. W. Odelberg) (*Pat. J.*, 1,660, 1920). No. 149,953, July 20, 1920. A machine for jolleying non-circular ware comprises a mould mounted on a disk which is grooved on the underside to engage a slide carried by a shaft, and is furnished with a depending pin engaging a cam groove in a stationary member secured to the table. The profile is adjustably mounted on a pivoted, counter-weighted arm.

MOULDING BRICKS, BLOCKS, ETC.—G. C. Thomas (*Pat. J.*, 1,660, 1920). No. 150,033, May 21, 1919. Relates to a machine for moulding one or more bricks, blocks, slabs, etc., at a time from concrete or clay.

MOULDS FOR SLEEPERS, ETC.—F. J. Gey (*Pat J.*, 1,662, 1920). No. 150,841, June 19, 1919. Description of a mould for the production of railway sleepers, etc., from plastic materials.

MOULDS.—J. Wallace (*Pat. J.*, 1,662, 1920). No. 150,846, June 21, 1919. Alabaster moulds are supported with a casing adapted to engage the jolley chuck. The bottom of the casing has a hole adapted to receive a projection on the bench to force the mould from the casing. The latter is slotted to reduce weight and is provided with internal flat springs to engage with and prevent rotation of the mould.

DISK-MILLS.—V. Antoine (*Pat. J.*, 1,655, 1920). No. 147,686, July 8, 1920. Description of an apparatus for grinding, crushing and dividing granular substances, comprising disks or plates provided with detachable working segments. The disks rotate in opposite directions.

PUG-MILLS.—E. Johnson, T. H. Gaskell & W. Boulton, Ltd. (*Pat. J.*, 1,656, 1920). No. 147,962, Jan. 14, 1919. The apparatus comprises a chamber, in which preparatory mixing and cutting takes place, and an enclosed pugging chamber for the mixture; a single shaft carrying blades passes through the two chambers, and fixed plates on the casing or perforated and slotted partitions coact with the rotary blades.

GRINDING-MILL.—H. T. Rudisill (*Pat. J.*, 1,657, 1920). No. 148,369, July 9, 1920. A machine for pulverising clay, quartz, etc., comprises two oppositely-rotating opposed containers having continuous, relatively deep peripheral walls, so that broken or loose material fed into the chamber or concavity between the containers is carried by centrifugal force to the peripheral portion of the chamber, and is held there so as to form grinding or crushing masses which are maintained by the action of centrifugal force.

EXCAVATORS.—P. Mogel & H. O. Kurth (*Pat. J.*, 1,653, 1920). No. 146,813, July 5, 1920. Bucket-line excavators for clay, etc., have cutters with cutting-edges, arranged at right-angles to each other, the cutters being wider than the beam carrying them. The cutters deliver to baskets with removable hinged caps.

MOULDING-MACHINE.—Soc. Le Basalte (*Pat. J.*, 1,653, 1920). No. 146,915, July 6, 1920. A machine for moulding articles of uniform size from plastic or molten materials irrespective of variations in the charge of materials.

MOULDS.—Soc. Le Basalte (*Pat. J.*, 1,653, 1920). No. 146,916, July 6, 1920. Description of a mould adapted to permit the ready release of the moulded product.

CONVEYERS.—J. West (*Pat. J.*, 1,654, 1920). No. 147,340, June 26, 1919. A means is indicated for preventing crushing of material during the movement of the closure-piece in an apparatus for transferring a measured quantity of material such as coke from a hopper to a bucket-conveyer.

FILTER-PRESS FRAMES.—V. Kemp (*Pat. J.*, 1,655, 1920). No. 147,652, July 8, 1920. The frames have their faces formed by the edges of flat iron bars or sheet-metal strips, having a width equal to the thickness of the frame and punched with holes. The ends of the bars may fit into dove-tailed grooves in the walls of the frame. Tie-rods pass transversely through the bars.

PULVERISING MILL.—Fuller-Lehigh Co. (*Pat. J.*, 1,650, 1920). No. 145,497, June 21, 1920. The invention is described in connection with a ball-and-ring mill. A settling zone is provided above the grinding zone of sufficient height to permit of the separation of insufficiently ground particles by gravity, and a superposed chamber is arranged above the settling zone with means for maintaining an upward flow of air from the grinding-zone, through the settling-zone into the superposed chamber to carry pulverised material through the mill.

PULVERISING MILL.—H. Cramm (*Pat. J.*, 1,650, 1920). No. 145,599, June 29, 1920. In rotating drum-mills, the drum is constructed with 3 or more flattened sides, instead of being cylindrical. This enables the drum, while rotating slowly, and without the aid of lifting ribs, to raise the roller or rollers to a considerable height before dropping.

SIFTER FOR GRINDING-MILLS.—E. E. Bentall, & G. C. Bingham (*Pat. J.*, 1,652, 1920). No. 146,583, Apr. 4, 1919. Description of an apparatus in which a rotary or grading sifter is supported on a grinding-mill so that it can swing clear of the delivery spout.

CONVEYING AND SCREENING APPARATUS.—R. A. Hadfield (*Pat. J.*, 1,652, 1920). No. 146,600, Apr. 7, 1919.

BRICK CONVEYORS.—Kr. (*Tonind. Ztg.*, **44**, 991, 1920). A description of a method of transporting bricks by rail or canal from the works to the building site. There are 4 illustrations.

WATER-JET SAND WASHERS.—(*Tonind. Ztg.*, **44**, 1270, 1920). A description, with illustrations, of the Körting apparatus.

A CHAINLESS CARRIER.—(*Tonind. Ztg.*, **44**, 886, 1920). A short description of an apparatus patented by the firm F. L. Smidth & Co., of Copenhagen. It consists of a carrying rail supporting the runners, with their vertical axes at suitable distances apart, to which is attached by steel joints a continuous line of short moveable boards, which obviates the necessity of a chain drive. The apparatus. which is illustrated, moves at the rate of 20 m. per minute and can thus deal with about 200 bricks per minute.

WASHING AND SCREENING PLANT FOR GRAVEL AND SAND.—Wetzel (*Tonind. Ztg.*, **44**, 930, 939, 1920). Investigations carried out at the various institutions for testing materials have shown that the quality of concrete depends mainly upon the choice, correct grain size, and purity of the gravel and sand employed, and not, as was formerly held, upon the cement content. The wet method (washing) is considered the better for preparing these raw materials, as the dry method is done mainly by manual labour and is therefore expensive. The article describes the machinery required and the method of laying out the plant, etc.

THE HOT METHOD OF PREPARING SAND-LIME BRICK BODIES (SCHWARZ MACHINE).—H. Jolig (*Tonind. Ztg.*, **44**, 953, 1920). A description of a machine for mixing the lime with the requisite quantity of sand by means of jacket and steam heating. A workable body is prepared by this method within about half an hour.

STEAM-METERS FOR SAND-LIME BRICK WORKS.—(*Tonind. Ztg.*, **44**, 641, 1920). To check the amount of steam consumed on a brick-works,

self-recording manometers are often fitted to the boilers. The writer considers that a more advantageous method is to measure the volume of steam drawn from the boilers by means of a recording meter, one type of which is illustrated.

RAMMING MACHINE FOR CEMENT GOODS.—(*Tonind. Ztg.*, **44**, 711, 1920). A description of a combined ramming, grinding and polishing machine.

AN OIL PURIFIER.—(*Tonind. Ztg.*, **44**, 622, 1920). The impurities, including water, are separated from the oil by the application of centrifugal force. The dirty oil passes into a centrifugal drum, which is made to revolve at a high speed, and finally passes through a very fine sieve. An illustration of the machine—the "Ahorn" is given.

A ROLLER TRACK-CONVEYOR FOR BRICKS.—(*Tonind Ztg.*, **44**, 622, 1920). An illustration of a roller conveyor to eliminate the handling of bricks and use of wheel-barrows, etc.

STEEL BELT CONVEYORS.—Anon. (*Tonind. Ztg.*, **43**, 1072, 1919). An illustrated description of the Swedish Sandwiken conveyor. The steel band undergoes a special tempering process, after rolling, which greatly decreases the tendency to rusting when used for conveying wet materials, such as wet salts in the potash industry. The length of the belt is practically unlimited. Its advantages as compared with other types are: (*a*) the surface is dense and hard; (*b*) its transverse rigidity; (*c*) its elasticity; (*d*) it does not stretch readily; (*e*) it is not sensitive to dampness or changes in temperature. As a rule, the gradient should not exceed 1 in 4. The belt can be used to convey hot material up to 120°C.

III.—FINISHED PRODUCTS: TESTING, ETC.

NOTES ON THE ELECTRICAL BEHAVIOUR OF PORCELAIN AND GLASS AT MODERATELY HIGH TEMPERATURES.—R. F. Earhart (*Ohio J. of Science*, **16**, 81, 1916). The experiments described were suggested by earlier tests on the conduction of electricity through gases at high temperatures. They were carried out by the author during the winter of 1912-13. It was noted during these earlier experiments that, when subjected to a high e.m.f., the porcelain (containing the gases) was traversed by a current of some magnitude, and that while the e.m.f. was steady the current through the porcelain steadily decreased with time.

Initial tests were carried out to measure the potentials required to break down porcelain insulators. In general, when such a body breaks down under electric stress, a mechanical puncture results, and the body ceases to be an effective insulator when again subjected to high potentials. But at a temp. of 300°C. such a sharp indication was not obtainable, and when the insulators were allowed to cool down again to room temperatures, it was found that their insulating powers had not been impaired. This indicated that a change in conductivity had taken place in the bodies. The effect of applying an e.m.f. is to develop a back e.m.f., and the condition of establishing a bridge balance becomes a function of the true resistance of the arm containing the specimen and the e.m.f. of polarisation as well. The transmission of a current through porcelain bodies has been regarded at times as similar to metallic conduction, at other times as electrolytic in character.

The general plan adopted in the experiments was to employ the high potential storage battery in the laboratory for maintaining constant and fairly high potentials (up to 1000 volts), and apply the potentials directly to the specimens, at the same time measuring the current. Then, from Ohm's Law, $V_1 - V_2 = RI$ = potential difference in volts, I = current in amperes, R = resistance in ohms. The arrangement of the circuits was quite simple. The battery has one terminal earthed. The other terminal is connected to the specimen through a high resistance tube, 80 cm. long and 2 cm. in diam.

containing a 25% solution of cadmium iodide in amyl alcohol. A Weston voltmeter, with a multiplier, measured the potential difference between the upper surface of the specimen and the earth. The terminals are cadmium. This gives a high resistance quite free from polarisation and capable of carrying currents of 50 milliamperes. An ammeter introduced between the specimen and the earth measured the current passing through the specimen only. Samples of porcelain were moulded into cylinders 2 cm. in diam. and 2 cm. long. The ends were ground plane. The furnace proper consisted of two porous battery jars, with bottoms removed, placed end to end. Over this resistance wire was wound. This was covered with asbestos paste and baked on. The furnace was then placed in a section of asbestos steam pipe jacket. A thermo couple (Pt. Rh-Pt.) projected into the furnace chamber. From below, a thick rod of copper, with a copper cylinder screwed to the top, projected into the heating chamber. The upper surface of the copper cylinder was covered with platinum, which served as an electrode pressing against one face of the porcelain cylinder. Above the specimen, a rod, similarly terminated, rested on the upper surface of the specimen, This rod had freedom of motion through guides to allow for expansion. It was found that a steady temperature of 500°C. could be obtained 5 or 6 hours after turning on the current, and that this could be maintained constant, plus or minus 3°, for a period of several hours. The specimen is so mounted that the stream lines of flow are perpendicular to the electrodes and parallel to the axis of the cylindrical specimen.

The current of this character may be designated No. 1 type, and is the one which is to be measured. There are two other possibilities: No. 2, a possible leakage from one terminal to the other over the surface of the porcelain; No. 3, a current passing through the hot gases surrounding the body. The current passing through the cylinder and the ammeter appeared to be separable into two parts, one which decreased rapidly with time, and one which, if it changes at all, does so at a much lower rate. The current decreased initially very rapidly with time, and then at a much diminished rate. Leakage of type No. 2 (above) was prevented by a glass tube arrangement with a guard ring attachment connected to earth. Glass specimens of similar form were also tested. The method employed was to maintain a certain predetermined temperature through a single experiment. A constant potential was applied and the current noted at time intervals. The continued decrease in current as time passes is held to be due to a back e.m.f. which may attain any value short of the applied e.m.f. In plotting the results, it was found that, after the curve had been followed out to the flat portion, the e.m.f. might be removed for a short time (2 minutes), and the curve taken up on re-application of the e.m.f. without any discrepancy. In some cases, after application for a half hour in one direction the battery was reversed, so that the impressed e.m.f of the batteries acted in the same direction as the previously generated back e.m.f. The time-current curve showed this effect, the initial values of the current were larger and the time taken for the curve to attain the flat portion was much longer.

STREET PAVING WITH SAND-LIME BRICKS.—H. Jolig (*Tonind. Ztg.*, **44**, 703, 1920). Paving bricks, measuring 65 × 140 × 290 mm., made of fine, best quality sand with 11% of lime and having a crushing-strength of 320 kg/sq. cm., were laid in Brody prior to the outbreak of war at the rate of 1,000,000 per annum. In spite of the excessively heavy war traffic during 1½ years, when Brody lay only 3 km. behind the front, the bricks are still in an excellent condition. Measurements made on trial bricks taken from the streets after 10 years wear, showed that the surface had worn down to the extent of 10 to 20 mm. The streets paved with sand-lime bricks were provided with specially-shaped kerbstones of cement.

THE GRADING OF REFRACTORY PRODUCTS.—J. A. (*Tonind. Ztg.*, **43**, 937, 1919). The present hap-hazard way of classifying refractory materials should be systemised. Two methods of grading are proposed: (1) ac-

cording to composition: (2) according to the purpose they are intended to serve.

THE GRADING OF REFRACTORY BRICKS.—O. Böndel (*Tonind. Ztg.*, **43**, 1249, 1919). The melting point of refractory bricks should not be below cone 26. The following types should be distinguished: I. Grog bricks, consisting mainly of refractory clay, subdivided into: (*a*) pure grog bricks made of refractory clay mixed with grog; (*b*) sand-clay bricks; (*c*) quartzite-clay bricks; (*d*) quartz-grog bricks. II. Quartz bricks: (*a*) lime-quartz bricks, consisting of quartz rock and lime, such as Dinas bricks (with rock quartzite) and silica bricks (with "Findlingsquartzite"); (*b*) clay-quartz or clay-Dinas bricks, containing quartzites with clay binder.

THE PHYSICAL PROPERTIES OF PORCELAIN.—F. Singer & E. Rosenthal (*Ber. D. K. Ges.*, **1**, (3), 47, 1920). The paper gives a good summary of the work done and results obtained in testing porcelain. There are numerous references.

FIRE-BRICKS.—T. W. Keillar (*Pat. J.*, 1,643, 1920) No. 142,955, Feb. 28, 1919. Fire-clay or silica bricks are rendered less heat-conducting by the provision of a cavity loosely packed with kieselguhr, which may be inserted through a hole subsequently sealed by a fire-clay plug; alternatively, the material may be introduced, with or without an envelope, into an open cavity and enclosed by a cover of fire-clay, or the brick may be moulded round an envelope containing the kieselguhr.

ROOFING TILES.—J. G. Woodman (*Pat. J.*, 1,645, 1920). No. 143,689, Apr. 14, 1919. The tiles are formed on the underside with a longitudinal rib, the upper end of which projects a certain distance and carries a rib, the lower end being shortened by a similar distance. In addition, there is a transverse rib near the upper edge and a corresponding underside groove near the lower edge. Longitudinal grooves may also be provided which, in the case of alternate tiles, may be filled with cement prior to assembly for preventing creeping of moisture.

ROOFING-TILES.—H. C. Badder (*Pat. J.*, 1,645, 1920). No. 143,783, Sept. 29, 1919. Underlying and overhanging flanges are formed at the two side edges, the underlying flange having a relief ridge to engage with a groove in the overhanging flange of the adjacent tile.

TESTING HARDNESS OF MATERIALS.—P. J. Steinke (*Pat. J.*, 1,658, 1920). Nos. 149,200/1, July 12, 1920. Description of a particular construction of hardness-testing apparatus in which the determination of hardness depends upon the height of rebound of a pointed hammer when dropped from a fixed height.

JOINTS FOR EARTHENWARE.—W. Hayhurst (*Pat. J.*, 1,682, 1921). No. 158,427, Nov. 24, 1919. Earthenware or ceramic materials are jointed together, or to metal, by means of a cement formed by the interaction of an aldehyde with phenol, cresol or a homologue thereof, with or without a suitable filling-material such as asbestos. The cement is filled into a recess in one of the parts, caused to set by heating to 100 or 150°F. and prepared to receive the other part by tapping, key-slotting, etc.

WAR EXPERIENCES WITH REFRACTORY BRICKS IN THE GERMAN NAVY; THE QUESTION OF STANDARDISATION.—Schulz (*Tonind. Ztg.*, **44**, 1097, 1920). Taken from a report published in "*Brennstoff und Wärmewirtschaft.*" The complaints brought forward by naval commanders are first dealt with, including too rapid deterioration of the bricks at the slag zone, although they possessed the required refractoriness as measured in Seger cones, partial destruction of dynaxite bricks by slag, short durability of grog bricks and low resistance of the bricks to mechanical action. As the result of a conference between Admiralty officials and 12 of the more important manufacturers, it was stipulated that the bricks must be dense, firm, and fired as sharply as possible (cones 10—14) and that they

must have a clear "ring" and not crumble or become rough when one brick is rubbed against another. For naval purposes, shale-grog bricks were found suitable with ordinary slags, but when the latter have a high silica or iron content, these bricks deteriorate rapidly. Dense grog bricks must then be used for the slag zone. Admiralty regulations prescribe: 1. Heavy bricks for those parts coming in direct contact with the burning coal or oil; 2. middle-weight bricks for the parts which come in contact with the flames only, and 3. light bricks for the parts not reached by the flames. The minimum melting points for the bricks must be: cone 34 for 1, cone 31 for 2 and cone 26 for 3. The heavy bricks of fused shale must contain at least 38% alumina

The question of standardisation of refractory bricks is approached as follows: 1. It is urgently recommended that manufacturers and users should agree upon a uniform nomenclature for the various kinds of bricks; 2. It is advisable to state the uses to which the different bricks may be put, in as much detail as possible. Further, the users should be given to understand that there can be no "best" brick for all purposes; directions should, however, be drawn up to enable them to make use of the results of scientific investigations upon the bricks. Until these, and similar, matters are satisfactorily settled, it would appear to be futile to attempt to fix standards of quality and serviceability.

BENDING STRAIN OF FACE AND SAND-LIME BRICKS.—Anon. (*Tonind. Ztg.*, **43**, 922, 1919). The bending strain is calculated from the formula: $B \frac{P\,l.}{4\,R}$ where P = load, l = length between supports, and R = resistance factor. R also $= \frac{bh^2}{6}$, where b = width of specimen, h = height in section. Then $B = \frac{3\,P.\,l}{2b\,h^2}$. The following values were obtained experimentally:

No.	Description	Mean Crushing load dry kg./sq. cm.	Bending strain kg./sq. cm.
1	Face Brick	508	87
2	do.	455	107
3	do.	452	75·5
4	do.	368	86
5	Ordinary Brick	237	34·6
6	do.	207	41
7	do.	200	52

The bending strain appears to be about $\frac{1}{4}$ to $\frac{1}{6}$ of the crushing load in the dry state. For sand-lime bricks, the bending strain, in three experiments, was found to be 19·5, 28·3 and 30·9 kg./sq. cm. respectively; the crushing load, in two cases, was 273 and 324 kg./sq. cm.

THE EFFECT OF AN ELECTRIC CURRENT ON BRICKWORK.—(*Deut. Töp. Zieg. Ztg.*, **50**, 429, 1919). Tests were carried out by L. Reese, on plates measuring approximately $12 \times 12 \times 1{\cdot}5$ cm. The lime mortar plates consisted of one part of lime to 3 parts sand, and for the cement mortar, 1 part of cement to 3 of sand were taken. Weak or stray currents due to telephone, telegraph, or electric bell installations have practically no effect on the structure of the wall. Bricks, lime and cement mortar were subjected to a 220-volt A.C. and D.C. and were unaffected after 20 minutes. Upon saturating the test pieces with water, a current penetration of 4—9 amperes was observed, water vapour being rapidly evolved. This increased after one minute, a bubbling and boiling effect lasting for about 2 minutes. After

about 6 minutes, the plates became dry, and the current ceased. The experiments were repeated several times, but the plates appeared to have undergone no change. Similar tests were carried out with 500-volt D.C. and 800, 2400 and 6000-volt A.C., but the plates showed no trace of damage. Experiments with the electric arc on the same material proved slightly less satisfactory. The plates showed signs of melting on the surface to a depth varying from 0·5 to 2 mm. Cement mortar was least affected. Glazed bricks were also subjected to the electric arc test, and the whole of the 15 specimens, of various makes, were destroyed within 2 minutes. For this test, an electric arc of 25 amperes and 440-volt D.C. was used.

TESTING MATERIALS.—(*Tonwar. Ofen. Ztg.*, **43**, 27-8, 41, 1919). The tests were carried out in the Testing Department of the Berlin Technical College. Bricks were tested for soluable salts and the effect of weathering, in order to determine whether they were likely to be destroyed by weathering. The question was answered in the negative, although there was evidence of more or less blistering. Two types of grog bricks showed a mean expansion in length of 1·8 and 2·4% at 1200°C.

UTILIZATION OF OLD PLASTER MOULDS.—E. Kirchheim (*Tonind. Ztg.*, **44**, 1206, 1920). K. suggests that old plaster moulds may be ground up and used in the chemical industry for packing corrosive liquids in the same way as infusorial earth is employed at present. The ground plaster would have a high absorbing power.

THE CRUSHING STRENGTH OF FULL AND PERFORATED BRICKS.—Hielscher (*Tonind. Ztg.*, **44**, 878, 1920). Perforated bricks leave the press in a denser condition, and, owing to the perforations, can be more thoroughly fired than full bricks. Figures are given, showing that the crushing strength of the former is about 21% greater than for full bricks.

AIR CRACKS IN GROG PRODUCTS.—Fischer (*Tonind. Ztg.*, **44**, 1170, 1920). The cracks are produced by air which has become trapped in the body. Mixing methods often tend directly to produce this undesired result. A further cause may also be found in the method of forming as for instance with glass pots.

THE BEHAVIOUR OF REFRACTORY BRICKS UNDER LOAD AT HIGH TEMPERATURES.—K. Endell (*Stahl and Eisen*, **41**, 6, 1921). An account of experiments carried out by the writer at the Technical High School, Charlottenburg, during the period 1918—20, the object being to determine comparative values for the behaviour of refractory bricks under load at high temperatures. There are 5 photographic illustrations. The apparatus used consisted of a lever press, the lever being a I iron bar about 4 m. long. The pressure stamp was made of specially hardened electrode carbon. The test pieces were cylindrical in shape, 50 m/m. in diameter and 50 mm. high. The lever is pivoted at a point about 400 mm. from the centre, and the shorter end is weighted to balance the longer arm. Pressure is applied to the test piece at the centre of the lever, that is, at a point 400 mm. from the pivot, by weights placed in a scale at the end of the lever at a distance of 2000 mm. from the sample. This means that a weight of 4 kg. in the scale exerts a pressure of 20 kg. on the sample, or 1 kg. per cm^2., since the area of the cylindrical sample actually under pressure is 20 cm^2. A pointer attached to the lever at a point about 500 mm. from the weight scale indicates exactly the movements of the lever on a millimetre scale. The furnace used was of the large Tammann type, with a diameter of 120 mm. The furnace cylinder was bored through to permit of the use of an optical pyrometer for the accurate measurement of temperature. The results obtained are shown in the following table:

Description	Melting Temperature	Highest Temp. reached	Softening Temp.	Thickness of Sample reduced from 50 mm. to	Heating Period		Remarks
					Total	Over 900°C.	
Grog Bricks ..	Cone 33 ~1730°	1500°	about 1300	30 mm.	4 h. 30 m.	3 hrs.	Sample showed lateral bulging as a result of homogeneous deformation.
Magnesite Bricks	>2000°	1650°	about 1500°	10 mm.	4 h. 45 m.	3 h. 30 m.	Sample cracked round the outside and showed only slight deformation.
Silica Bricks ..	Cone 35 ~1750°	1680°	about 1650	broken down	4 h. 10 m.	2 h. 50 m.	Sample is broken down ; pieces only slightly deformed.
Carbon Bricks	>2000°	1720°	Does not soften		4 h. 55 m.	3 h. 25 m.	Sample retains its form. Some carbon appears to be burned away, and the binding medium to have been vaporized hence volume change of about 4%.

PORCELAIN INSULATORS.—O. Boudouard (*Rev. Gén. de l'El.* **7**, 691, 1920). A sub-committee report to the "Union des Syndicats de l'Electricité" on the chemical study of porcelain insulators. Six tables giving information regarding the insulators and tests are included. Thirty-one specimens were examined, 5 of German, 4 American, 21 French, and 1 of unknown origin. Analyses showed great variations in the composition of the porcelain: SiO_2 varied from 63·31 to 74.49%, Al_2O_3 20·45 to 29·75%, CaO 1·9 to 3·98%, alkalies 3·23 to 6·45%, whilst the ratio $\frac{SiO_2}{Al_2O_3}$ varied from 3·64 to 6·33. With regard to the relationship between chemical composition and the durability of the insulators in use, it was found that porcelains containing much silica or CaO gave unsatisfactory results. From the point of view of the ratio $\frac{SiO_2}{Al_2O_3}$ they represent an extreme group, and insulators made from them exhibit more or less serious defects in the making. Theoretical considerations led to the proposal to find substitutes for quartz and felspar in porcelain bodies. Quartz is piezo-electric and exists in several allotropic forms, whilst felspar is fragile and acts as an electrolyte. American ceramists have therefore made trials with porcelains in which the quartz is replaced by some inert substances (natural or synthetic sillimanite, kaolin, alumina and calcined zirconia) and felspar by silicates of alumina or magnesia or by the double silicates of glucinum and alkalies.

HIGH-TENSION INSULATOR PORCELAIN.—W. D. A. Peaslee (*J. Amer. Inst. E. E.*, **39**, 445, 1920). Factors to be considered in the selection of a porcelain body as a material for high-tension insulators are: (1) *Mechanical Strength.* This is obviously one of the prime factors, since one of the first duties of the insulator is to support the conductor. Ordinary porcelain containing clay, flint and felspar, has been found by several investigators to have strengths reaching as a maximum 40,000 lb. per sq. in. for compression and 1500 lb. per sq. in. for tension. The wide difference between these values has led many engineers to distrust porcelain used under tension, but provided the stresses are kept within the proper limits there is no more valid ground for this attitude, from an engineering safety-factor point of view, than would be the case with cast iron used under tension. Under the stimulus of the demand for better insulation, a great deal of work has been done on porcelain bodies, and certain types are now available whose strength runs up to 65,000 lb. per sq. in. in compression and 12,500 lb. per sq. in. in tension. These figures do not represent the ultimate limit, as there are indications pointing to the commercial production of bodies with even greater strength.
(2) *Ability to Resist Sudden Changes in Temperature.* Any body which, in the shape and size as employed, and completely equipped with hardware, will not withstand an indefinite number of alternate immersions in boiling and freezing water, should never be used in the manufacture of high-tension insulators. Some bodies will stand even greater ranges. At least two are known which can be heated red hot and thrown into cold water without cracking. (3). *Porosity.* The writer challenges the statement that non-porous porcelain cannot be produced. On the contrary, porcelain can be made, under manufacturing conditions, which in an engineering sense is absolutely non-porous. This statement is made after much careful research and on the strength of many porosity tests both by the impregnation and the psyc rometer methods. The two kinds of porosity—open and closed pore types—are generally the result of under and over-firing respectively, though in many instances over-firing produces the first type. The latter statement can very readily be proved by proper tests. For production control, a very valuable testing method has been developed. A solution of fuchsine dye in wood alcohol is used and unglazed pieces placed in it under pressure. The slightest degree of porosity of the open pore type is indicated by a deep penetration of the dye unto the body of the test piece. Closed pore porosity is commonly indicated by a swelling of the insulators, and can be watched closely by

gauges applied to the finished product. (4). *Temperature Resistivity Coefficient.* For porcelain, this is large and negative. Curves showing the resistance in megohms as a function of the temperature, for a standard or "conventional" and a "new" body, are given. The "conventional" sample has a resistance of two megohms at 371°C., whilst the "new" body in an exactly similar piece has the same resistance at 627°C. This property of porcelain may be improved, but it will always be negative even in pure quartz. (5). *Piezo Electric Effect.* The deterioration of seemingly perfect units after a time, and the acquiring by non-porous porcelain of a certain porosity, have been shown by recent investigations to be intimately connected with piezo electric qualities of quartz crystals. As ordinarily made, porcelain consists of rather large particles of quartz in a vitreous matrix. If certain crystals such as quartz are subjected to a pressure on two diametrically opposite faces parallel with the major axes, a potential difference is set up on the faces perpendicular to those upon which the pressure is applied, which varies directly as the pressure. The converse is also true, and if a difference of potential is applied to two opposite faces parallel to the major axes the crystal is subjected to a squeezing action and a change in dimensions of the crystals results. If strongly resisted by the surrounding matrix, these changes in dimensions will set up enormous local stresses between the magma and the crystals. When this porphyritic mass is placed in an alternating electrostatic field, a large number of the quartz crystals are so arranged, according to the theory of probabilities, that their major axes are not parallel to the field of force, so that, in the case of a 60-cycle system, a change in mechanical dimensions is set up in the crystals 120 times per second. This results in a vibratory movement, which may be detrimental in two ways—first a rupture of the crystal itself, along cleavage planes, and second a rupture between the crystals and the matrix. A concentrated leakage current results through the spaces between the magma and the crystals when the crystal is at its greatest deformation and the potential differences are at maximum. It will also tend to make the porcelain porous in an entirely different manner (by cracks and fracture voids) from the types mentioned previously, and the vibratory action of the crystals may aid in the introduction of moisture into the body. The solvent action of such moisture may have an accelerating effect upon the deterioration of the porcelain. Regardless of the degree to which this effect contributes to the deterioration of high-tension porcelain, the body to be sought is one in which the quartz is dissolved as completely as possible in the felspathic matrix.

SURFACE LEAKAGE AS A FACTOR IN INSULATOR DESIGN.—T. M. Feder (*J. Am. Inst. E. E.*, **39,** 803, 1920). The writer discusses from a theoretical standpoint the methods of increasing the surface resistance of insulators to leakage. The article contains several diagrams and curves. Making the insulators larger, *i.e.*, increasing the diameter, involves an increase of the area of the conducting film, and, all things considered, is a process of doubtful economic value. Another scheme of increasing the surface resistance, and the one usually adopted, is the adding of corrugations on the under side of the flange, thus increasing the length of leakage path without affecting the diameter of the unit. One corrugation at 4 in. radius is equivalent to changing a 12 in. disk to one of 22-in. diameter considering only resistance gained, with corresponding increase in weights, of 16% and 240% respectively. Corrugations add an amount of resistance which varies inversely as the radius to the centre line of the corrugation. They should be made heavy enough to resist shocks or power arc. Thin, deep corrugations are mechanically weak and should be avoided. With a rational design, the body of the unit conforms to the flow lines of dielectric flux ; the electrostatic stress along the surface is everywhere tangential, and tends to throw off all foreign matter which may otherwise form a conducting path. The areas immediately surrounding the electrodes are thus kept clean and the surface resistance is a maximum. But this applies to insulators in a dry condition only.

IV.—MANAGEMENT, ORGANISATION, COSTING, ETC : COMMERCIAL.

CLAY AND MARL EXCAVATORS.—J. Strehl (*Tonind. Ztg.*, **43**, 793, 1919). A discussion of the question as to whether an excavator can be run as a paying concern in small and medium-sized brick works.

THE DEVELOPMENT OF THE REFRACTORY INDUSTRY IN GENERAL AND DURING THE WAR IN PARTICULAR.—H. Geyer (*Ber. D.K. Ges.* **1**, No. 2, 33, 1920). There are at present about 100 works engaged in the German refractory industry, with an annual production of about 600,000 tons grog material and about 200,000 tons Dinas bricks. In addition, these works supply raw materials in the shape of prepared clays, quartz sand, etc., so that in all a total annual production of about 1,000,000 tons of refractory material can be reckoned with. From 250,000 to 300,000 tons of coal are used in the manufacture of the above mentioned quantities of grog and Dinas material. A sharp rise in production took place between 1902 and 1908, followed by a slight decline until 1912. From 1912 to the outbreak of war production again increased rapidly, but fell away sharply from 1914 to 1916. A slight rise took place from then until 1918, since when, owing to the coal scarcity and shorter working hours, production has steadily declined.

THE MANUFACTURING COST OF BRICKS.—(*Tonind. Ztg.*, **44**, 653, 1920). Figures are given to show that the cost of labour for hand-made bricks rose by 213% from 1913 to 1919 and for machine-made bricks by 229%.

THE WAGES QUESTION IN THE BRICK INDUSTRY.—A. Milde (*Tonind. Ztg.*, **44**, 710, 1920).

TRADE COMBINES.—Ch. Cirkel (*Tonind. Ztg.*, **44**, 1309, 1920). In recent years economic forces have induced the different branches of industry within limited areas to join forces with a view to taking united action in matters of common interest. The writer discusses the formation of such a combine among the brick-making and allied industries of the Osnabrück district. The movement received its main impetus from the coal shortage. The coal placed at the disposal of the works was only sufficient to maintain a few of them working full time. A number of works had to be closed down, and the coal distributed among the remainder in the most economical manner possible. The closed works received compensation according to a pre-arranged "participation figure." For every 50 kg. of coal received, the works had to pay a monthly sum of 1·50 to 1·80 marks to the general funds. The advantages claimed for the system are : (1) the most economical distribution of the available coal ; (2) greater earning capacity of the works, since loss of time and money in procuring fuel, or in temporary stoppages owing to coal shortage are almost unknown ; (3) fair compensation for the works closed down, enabling them to meet their obligations.

AN OBJECT LESSON.—Oesterling (*Tonind. Ztg.*, **44**, 885, 1920). As an example of the unhealthy condition of industry under state control, the case of the Hibernia Mining Concern in Herne (Westphalia) is quoted. When under private management, this company was among the most successful in the Ruhr district. For many years it has been under the almost complete control of the Prussian State, which holds 59 out of the 66 million marks ordinary shares and the whole of the 10 million preference shares. The profits have steadily decreased, and last year, for the first time since the concern was founded, no dividend was paid on the ordinary shares.

LIME AND THE SAND-LIME BRICK INDUSTRY.—B. Krieger (*Tonind. Ztg.*, **44**, 774, 1920). Statistics are quoted showing that the annual production of the German sand-lime brick works in 1919 was 1·4 milliard bricks working day shifts only, and 2·1 milliard working day and night shifts. The

calculated quantities of lime and fuel required for this production are as follows :—

Annual Production in milliards	Coal	Briquets	Raw brown coal	Coal for burning lime	Lime	Total coal
1·4	210,000	315,000	525,000	80,000	315,000	290,000
2·1	315,000	474,500	787,500	118,000	472,500	433,000

THE VALUATION OF CLAY DEPOSITS.—Anon. (*Tonind. Ztg.*, **43**, 1123, 1919). The deposit must first be systematically bored and carefully surveyed in order to arrive at a correct estimate of the quantity of clay available. The capital value can then be determined by considering the annual profit derived from the deposit as interest yielded by the capital represented by the quantity of clay available ; this is based on the number of years required to exhaust the deposit which is calculated from the estimated annual yield of clay. The formula is as follows : $C = P\frac{p^n - 1}{p^n(p-1)}$ where C is the value of the clay deposit, or the capital required, P the annual profit, n the number of years the deposit will last, and $p = 1 + \frac{k}{100}$ where k is the rate of interest.

PROPER APPRECIATION AND REMUNERATION OF SCIENTIFIC WORK IN THE CERAMIC INDUSTRY.—Koerner (*Sprech.*, **53**, 571, 1920).

THE TAYLOR SYSTEM.—O. J. Gérin (*Cer.* **22**, 92, 1919).

WORKS-MANAGEMENT IN A CEMENT FACTORY. O. Schott (*Tonind. Ztg.*, **44**, 438, 1920). A short discussion of the methods to be adopted to determine the work performed by mills and kilns, the amount of fuel consumed, etc.

MORE BOOKKEEPING.—W. B. S. (*Tonind. Ztg.*, **44**, 448, 1920). The writer holds that this important branch of works management is still greatly neglected. Particularly is this the case in dealing with raw and works materials. The quantity of raw materials should not only be booked on arrival, but the amounts required from time to time for the preparation of bodies, glazes, etc., must also be carefully written off.

SOME GENERAL REMARKS ON FACTORY ORGANISATION.—(*Sprech.*, **53**, 493, 1920).

THE SITUATION IN THE GERMAN GLASS AND CERAMIC INDUSTRY.—(*Sprech.*, **53**, 493, 1920). The problem of how to meet the unemployment which threatened the German people was recently considered by the Federal Economic Council. Experts from the various branches of industry were called. It was generally held by both employers and employed that the question of fostering and facilitating the export trade was of paramount importance.

THE POTTERY INDUSTRY IN 1919.—(*Chem. Met. Eng.*, **23**, 692, 1920).—A preliminary survey made by the U.S. Geological Survey. The statistics were compiled by Jefferson Middleton.

THE FATE OF THE PIECE-WORK SYSTEM IN BOLSHEVIK RUSSIA.—Anon. (*Deut. Töp. Zieg. Ztg.*, **50**, 528, 1919).

ON THE UTILIZATION OF STONEWARE.—Ka. (*Tonwar. Ofen. Ztg.*, **43**, 87, 1919).

THE SITUATION IN THE SWISS CERAMIC AND GLASS INDUSTRY.—(*Sprech.*, **53**, 525, 1920).

WORKS' COUNCILS AND TRADE UNIONS.—B. Juster (*Tonind. Ztg.*, **43,** 1373, 1919). A criticism of Article 165 of the German Constitution, according to which "the workmen, for the protection of their social and industrial interests, are to be represented on all works' and district Councils and also on the National Labour Council." The writer is of opinion that the Council System, which was copied from Russia, where there were no powerful Trade Unions, is quite unsuited to German conditions, and that the government should have done all in its power to further the Trade Union movement instead of grafting the Council System into the constitution.

PROBLEMS OF THE PORCELAIN INDUSTRY.—F. Singer (*Dingler's Polytech. Jour.*, **335,** 96, 1920). A general survey of the more urgent problems with which the German Porcelain industry is at present faced, namely: standardisation, increase in the quantity and quality of production, and fuel economy. The "history" of porcelain, from its accidental discovery by the Chinese in the 9th Centuary A.D., is briefly sketched. Only in comparatively recent times has porcelain been brought into use for technical purpose, *i.e.*, for electro-technical and chemical appliances. The glaze is rendered more resistant to the action of chemical re-agents, particularly of acids and bases, by increasing the silica and alumina content. With regard to insulator porcelain, the greatest difficulty is met with in testing for physical properties; owing to the brittleness of the material, it is by no means an easy matter to prepare suitable test-bars, which will give accurate indications of the properties of the bodies. No definite relationship has yet been discovered between the figures for constant load and the percussion test. In high-tension porcelain insulators consisting of several parts, it was found that breakage sometimes occurred owing to the difference between the coefficient of thermal expansion of porcelain (0·00000379) and that of the cement (0·00001100) which served to bind the parts together. (See *Trans.* **19,** Abs. 153, 1920). Attempts are being made to produce a cement with coefficient of expansion approximating to that of the porcelain, and several patents have already been applied for. It is claimed that, during the war, satisfactory substitutes for foreign raw materials, such as ceramic colours, English kaolin, etc., were developed in Germany. Numerous articles formerly made of other materials, such as door-latches, window clasps, weights, mortars, lamp-stands, etc., were manufactured of porcelain. On the other hand, attempts to make Dewar vessels and hand grenades of this material were unsuccessful. Normal porcelain softens at about 1500°C., special porcelain bodies at 1700°C. The Marquardt body, with a melting point of 1850°C. cannot be considered as a porcelain since it does not fire dense, white and transparent. The same applies to other refractory materials such as Al_2O_3 (2050°), SiC (2500°), MgO (2800°), ZrO_2 (2950°) and BN (over 3000°C.).

THE FUTURE CONSTITUTION OF WORKS MANAGEMENT.—O. Röthke (*Tonind. Ztg.*, **43,** 1001, 1919). Works Councils must be formed in all German concerns employing a minimum of 20 workpeople, including office staff. They are elected by the employees, all of whom are entitled to vote if over 18 years of age. All future engagements or dismissals of employees must be submitted by the employer to the Works Council for approval. The law also empowers the Council to elect one or two representatives on the Board of Directors, where such exists, and to these, all balance sheets, profit and loss accounts, etc., must be submitted. In case of the disclosure of business secrets, the guilty party is liable to a penalty not exceeding 1500 marks.

PIECE-WORK.—Anon. (*Tonind. Ztg.*, **43,** 1043, 1919). A short article, in which the writer puts forward the opinion that the group system is the most suitable for the brick-making industry.

THE TAYLOR SYSTEM APPLIED TO BRICK TRANSPORT.—Anon. (*Tonind. Ztg.*, **43,** 1043, 1919).

ENDLESS CONVEYORS OR AUTOMATIC CARRIERS?.—(*Tonind. Ztg.*, **44**, 499, 1920). A comparison of the two methods of transporting ware. Automatic carriers eliminate all handling of the green ware from the press to the kiln. The choice between the two systems will depend upon the particular circumstances in each case.

BOOK-KEEPING ON BRICKWORKS.—(*Tonind. Ztg.*, **44**, 463, 1920). A common mistake is to attempt to book all details on one works sheet. Examples of seven different sheets for various purposes are given.

COST ESTIMATION OF SAND-LIME BRICKS.—(*Tonind. Ztg.*, **44**, 527, 1920). Seven specimen Works-Sheets are given in the article to illustrate a method of keeping an exact account of the cost of raw materials used, cost of transport, wages, etc. The final summary includes columns for spare parts, fodder, straw, upkeep of vehicles, etc., and enables the average annual cost of production to be determined from week to week.

GOVERNMENT CONTROL.—P. Ermisch (*Tonind. Ztg.*, **44**, 571, 1920). A strong protest against all forms of Government control of industry.

THE EIGHT-HOUR DAY IN THE CERAMIC INDUSTRY.—F. Sperber (*Tonind. Ztg.*, **43**, 809, 1919). The writer recommends working in three shifts, from 6 to 10, 10 to 2, and 2 to 6 o'clock ; Saturdays 6 to 8, 8 to 10, and 10 to 12 a.m. The shifts might be arranged as follows, with the workmen divided up into 3 groups :—

	Shift 6—10.	10—2.	2—6.
Monday ..	Group I. ..	Group I. ..	Group II.
	,, II. ..	,, III. ..	,, III.
Tuesday ..	,, II. ..	,, II. ..	,, III.
	,, III. ..	,, I. ..	,, I.
Wednesday ..	,, III. ..	,, III. ..	,, I.
	,, I. ..	,, II. ..	,, II.
Thursday ..	,, I. ..	,, I. ..	,, II.
	,, II. ..	,, III. ..	,, III.
Friday ..	,, II. ..	,, II. ..	,, III.
	,, III. ..	,, I. ..	,, I.
	Shift : 6—8.	8—10.	10—12.
Saturday ..	Group III. ..	Group III. ..	Group I.
	,, I. ..	,, II. ..	,, II.

This scheme might be made subject to periodical rearrangement.

THE EIGHT-HOUR DAY IN THE BRICK INDUSTRY.—W. Matthes (*Tonind. Ztg.*, **43**, 833, 1919). Reply to above.

MANUFACTURING COSTS FOR FULL AND HOLLOW-BRICKS.—A. Z. (*Tonind. Ztg.*, **43**, 953, 1919). Records made by a large German works during the year 1913, tend to show that the manufacture of hollow instead of full bricks does not lead to fuel economy. Taking the values for the full brick as unity the following table is obtained :

Description	Power	Firing	Power & Firing
Full brick, 250 × 120 × 65 mm.	1	1	1
Hollow brick, 250 × 120 × 65 mm.	3.6	0·7	about 2
Hollow coping brick, 250 × 150 × 100 mm. ..	1·6	0·73	1·1
250 × 150 × 130 mm. ..	1·4	0·77	1·06

These figures justify the following general statement : "The consumption of coal is greater for hollow than for full bricks. The smaller the cross-section of the hollow bricks, the greater the coal consumption. The smaller quantity of coal required for firing is more than compensated for by the increased amount required for power production."

INDICATING PROGRESS OF WORK.—Mann, Egerton & Co. (*Pat. J.*, 1,645, 1920). No. 143,715, May 22, 1919. A device for indicating the progress of work passing through workshops, offices, etc., comprising a disk mounted on a stand and having movable pointers of different lengths. The disk has mounted on it a smaller disk, having radial nicks or grooves in which the ends of the pointers engage, both disks being mounted on a spring-pressed spindle so as to be independently rotatable. The pointers are spring-pressed and arranged one above the other, so as to be capable of passing one another in both directions. The outer part of the larger disk is covered with a removable surface, bearing annular columns carrying information which is diagnosed by one or more rotatable arms similarly divided A graph chart may be fixed beneath the disk.

BRICK MANUFACTURE.—H. Atkins (*Pat. J.*, 1,654, 1920). No. 147,239, Nov. 16, 1918. A plant for the manufacture of bricks, tiles, etc., comprises a moulding or loading house, a drying-kiln and a firing kiln arranged end to end, with a line of rails running through. Preferably two sets of plant are arranged side by side with a common return line of rails between.

V.—GLASS: GENERAL.

MEASUREMENTS ON THE THERMAL DILATATION OF GLASS AT HIGH TEMPERATURES.—C. G. Peters and C. H. Cragoe (*Amer. Bur. St. Sc. Paper*, No. 393, 1920). A review of previous research on the thermal expansion of glass shows that most of the determinations were confined to the temperature region below 100°C., except in a few cases where glasses of unknown composition were taken to 500°C. In this investigation, the dimensional changes of various glasses in the annealing and higher temperature region were determined. The Fizeau-Pulfrich interferometer was found to be particularly well suited to this work, since its extreme sensitiveness makes it possible to use small specimens, and the small size of the apparatus simplifies the problems of uniform heating and temperature control. The experimental method was as follows : The straight fringes produced by rays of light reflected from the two interferometer plates were observed with a Pulfrich apparatus. Any elongation in the length of the specimen which forms a separator for the plates causes a corresponding movement of the interference fringes past a reference mark. The dimensional change for a given temperature interval was given by the number of fringes which passed the reference mark on the front interferometer plate. The apparatus is described in some detail and a sectional sketch of the electric furnace is given. Observations were made in temperature regions between 20 and 650°C. on 32 different kinds of glass. Curves showing the dimensional changes of these glasses are given, which indicate that the glass passed through a critical expansion region, in which the expansion rate increases by 2 to 7 times. This critical region, which for any one glass does not exceed 40°, was found as low as 400°C. with Nos. 24 and 30, and as high as 575°C. with No. 11. About 75° above the critical region the glass softens and contracts. A comparison of the results shows that the heat absorption observed by Tool & Valasek occurs in the same temperature region as the critical change in the expansion. From these determinations of the dimensional changes of glass, the thermal expansion above and below the critical temperature, the temp. for most careful and thorough annealing, the upper limit for rapid annealing, and the region where careful cooling is essential, may be obtained. The annealing and critical ranges of several optical glasses, as determined by Tool & Valasek are given for comparison in the following table :

ANNEALING AND CRITICAL RANGES OF SEVERAL OPTICAL GLASSES.

No.	Name	Critical range of heating						Annealing range			
		Heat Absorption (Tool)		Rapid Expansion		Critical Region		Optical Method		Expansion Method	
		A ±10°C.	B ±5°C.	A	B	A	B	Anneal. temp. ±15°C.	Upper limit ±15°C.	Anneal. limit ±10°C.	Upper limit ±10°C
1	Barium flint No. 145 ..	520	560	520	570	500	525	515	550	510	580
9	Light crown No. 20 ..	495	525	500	525	460	500	480	530	480	530
10	Borosilicate crown, No. 94	515	565	535	570	515	535	525	550	525	590
11	Light barium crown, No. 87	575	605	585	610	545	585	570	610	565	620
12	Medium flint, No. 110 ..	455	485	450	680	430	450	460	510	440	500
13	Light flint, No. 188 ..	485	525	490	525	460	490	485	510	475	540

In this table, the upper and lower limits of the heat absorption ranges are given in column 3, A and B, and the annealing temperature and the upper limit for annealing—that is, the highest temp. to which the glass can be heated without noticeable deformation—in column 6.

ORANGE-COLOURED PLATE GLASS.—(*Sprech.*, 53, 500, 1920). Orange coloured glass is obtained by the use of cadmium sulphide and sulphur. A suitable batch contains 100 kg. sand, 45 kg. sodium sulphate, 10 kg. lime, 2·5 kg. charcoal, 1—2 kg. cadmium sulphide, 0·5—1 kg. flowers of sulphur. The following is suitable for a "case" glass : 100 kg. sand, 33 kg. soda, 13 kg. lime, 1 kg. manganese dioxide, 0·75 kg. graphite, 2 kg. arsenic, 4 kg. saltpetre, 1 kg. borax.

COPPER-RUBY GLASS FOR CASING.—J. Baldermann (*Sprech.*, **53,** 491, 1920). In the writer's opinion, the manufacture of a good ruby glass depends chiefly upon correct treatment during melting. The following batch is recommended : Sand 12 kg., red lead 28 kg., ground cullet 13 kg., red copper oxide 240 grs., stannous oxide 400 grs., ferrous oxide (yellow) 120 grs., pulverised iron filings 60 grs., tartar (red) 500 grs. It is important that the materials used should be as pure as possible and perfectly dry. As little time as possible must be allowed to elapse between mixing and melting. The latter should be carried out in small pots, the exterior dimensions of which should be approximately—for the upper diameter 43 cm., for the lower diameter 38 cm., and the height 38 cm. The copper ruby batch melts completely within 3 hours, it is therefore not introduced into the furnace until the second charge in the glass pots has melted down. To determine whether the ruby batch is thoroughly melted, a little should be taken out and formed into a thread. This should be perfectly smooth to the touch on passing through the fingers. After quenching in cold water, the cullet must be carefully dried ; 200 grs. finely ground borax, 200 grs. tartar and 12 grs. iron filings are then added, and the whole carefully mixed and heated at the maximum furnace temperature for about 3 hours. The same quality of cullet should be used in making both the case and the colourless crystal glass. This is advisable in order to secure a uniform tension between the two layers. Ruby glass deteriorates in quality and colour if exposed to continuous high temperature during melting. The moment when the melting is complete must be carefully watched as a difference of 10 or 15 minutes either way may have serious results.

COPPER-RUBY GLASS FOR CASING.—E. S. (*Sprech.*, **53,** 536, 1920). A reply to Baldermann (see above). The writer recommends the use of "ruby compositions" as supplied by certain chemical works. The batch would then be as follows : (1) for the crystal glass—100 kg. sand, 35 kg. soda, 13 kg. marble and 6 grs. nickel oxide ; (2) for the case glass—16 kg. sand, 6 kg. potash, 14 kg. red lead, 1 kg. ruby composition. These special preparations give a fine, uniform red, and are simple to use.

CIRCULAR FLATTENING OVENS AND LEHRS FOR PLATE GLASS, BOTTLES, ETC.—C. Baldermann (*Sprech.*, **53,** 444, 1920). A general description, with sketch, of a system for which the author claims certain advantages. The flattening oven and the lehr are built in circular form and connected tangentially with each other, so that, looked at from above, the structure has the appearance of a figure eight. Inside the ovens, the only means of conveyance is a revolving stage, upon which the flattening stones are placed. This stage can easily be set in motion by a boy of 16.

VITREOSIL GAS MANTLE PROTECTORS.—(*Man. Guard. Comm.*, **1,** 728, 1920). Vitreosil is a substance similar to high temperature laboratory glass, but much thinner. It is opalescent white, smooth and glossy on one side, wavy and semi-matt on the other. It is made into chimneys and globes for glass mantle protection by the Thermal Syndicate, Ltd. Though as thin and light as ordinary glass used for this purpose, it resists rapid variations of temperature, and is unaffected by a current of air or even splashes of water. In addition, the articles serve to retain the heat from the mantle, giving more

complete combustion and therefore more efficient illumination. The light is agreeably softened by the pearly white substance so that there is no glare. The process of manufacture, which gives to the articles a smooth, shiny outer surface and a wavy, semi-matt inner surface, ensures perfect dispersion of the light rays.

BOTTLE-MAKING MACHINE.—T. Berger (*Pat. J.*, 1,649, 1920). No. 145,336, Nov. 10, 1919. Relates to the pump mechanism of a bottle-making machine of the type in which the metal is sucked down into the parison mould by a hand operated pump which also serves to blow up the parison.

BOTTLE-MACHINE MOULDS.—T. Berger (*Pat. J.*, 1,649, 1920). No. 145,390, Nov. 10, 1919. The moulds of a bottle-making machine are opened and closed by eccentrics operated by hand.

BOTTLE-MACHINES.—T. Berger (*Pat. J.*, 1,649, 1920). No. 145,391, Nov. 10, 1919. A blow-head for the finishing mould of a bottle-making machine consists of spring-controlled, telescopic parts, whose displacement by means of a hand lever allows the air duct to be opened gradually.

GLASS FOR ELECTRIC LAMP BULBS.—Corning Glass Works (*Pat. J.*, 1,649, 1920). No. 145,428, June 17, 1920. The glass is composed as follows: Silica 100 molecules, sodium oxide 20 to 36 molecules, and at least one of the bivalent alkaline earth oxides 6 to 36 molecules. The Specification gives nine batch formulæ, the fifth being: SiO_2 100 molecules (or 63%), Na_2O 25·5 molecules (22·2%) and CaO, 7·9 molecules (8·8%).

GLASS MOULDS.—A. M. Glass (*Pat. J.*, 1,645, 1920). No. 143,792, Nov. 5, 1919. Powdered graphite after treatment with sulphuric acid and potassium chlorate is mixed with gas-retort carbon and partly carbonised sugar in a pug-mill. A mixture of caramelized sugar and water is then added, and the whole composition mixed to a stiff paste and pressed to the desired shape hydraulically. Articles produced in such moulds are stated to have a surface lustre and sharpness similar to cut glass.

GLASS-BLOWING MACHINE.—W. J. Miller (*Pat. J.*, 1,645, 1920). No. 143,827—Oct. 30, 1918.

GLASS MANUFACTURE.—Schlesische Spiegelglas-Manufaktur C. Tielsch, Ges. (*Pat. J.*, 1,645, 1920). No. 143,870, May 26, 1920. A process for the manufacture of armoured glass panes through separate cogging of two layers of glass in a flattening-mill, and subsequently compressing, with simultaneous insertion of the wire armour, in a direct-coupled pressing mill.

GLASS MANUFACTURE.—F. O'Neill (*Pat. J.*, 1,646, 1920). No. 144,344, Feb. 6, 1919. Relates to a semi-automatic pneumatically-operated machine for blowing glass bottles, etc., of the type in which turnover mechanisms are carried on rotating tables. According to the invention, the parisons are each transferred mechanically from the parison moulds to the blowing moulds and the circular paths of the moulds do not overlap.

GLASS FURNACES.—W. L. Pratt (*Pat. J.*, 1,647, 1920). No. 144,552, Nov. 6, 1919. Relates to apparatus for delivering uniform charges of glass from a tank furnace. According to the invention, the charge during extension is surrounded by a tubular member or box to prevent chilling, the box being movable downwards to permit shears to operate close to the orifice. The apparatus is operated by pneumatic power.

BOTTLE-BLOWING MACHINE.—Boucher et Fils. (*Pat. J.*, 1,647, 1920). No. 144,691, June 9, 1920. Relates to turnover machines of the Claude Boucher type. The molten metal in the parison mould is compressed by air admitted from a shaft through a pipe to the mould cover.

FROSTED GLASS.—T. Ueda (*Pat. J.*, 1,647, 1920). No. 144,737, June 12, 1920. Relates to a process for producing a matt surface on glass. According to the invention, the surface is coated with a composition containing a substance, which, when heated, reacts on the glass to form an acid-decomposable product.

The composition also contains a relatively inert substance and a binding-agent. The coated surface is heated to the required extent and, after cooling, the acid-decomposable matter is removed by an acid other than hydrofluoric. As an example, a composition consisting of basic lead silicate, pulverised porcelain and a binder such as gum is cited.

GLASS FURNACES.—Hartford-Fairmont Co. (*Pat. J.*, 1,642, 1920). Nos. 142,785/6, Jan. 15, 1920. Relates to delivery of uniform charges of molten glass from a tank furnace. The object of the invention is to deliver charges which are shaped to fit approximately the mould in which the charge is to be formed. Specification 105,672 is referred to.

GLASS BLOWING.—A. R. Hunter (*Pat. J.*, 1,643, 1920). No. 142,929, Feb. 13, 1919. Relates to a method of preventing the formation of too hard a skin on parisons owing to the chilling action of the parison mould and plunger. As soon as the pressing is completed and the plunger is withdrawn, the parison is raised out of contact with the mould by a rod, or the mould is opened slightly. The chilled surface of the parison is reheated and softened by heat from the interior mass of the glass by the time the parison is removed for blowing.

GASEOUS-FUEL FURNACE.—T. G. Riley (*Pat. J.*, 1,643, 1920). No. 143,049, May 27, 1919. In a reversible regenerative glass melting furnace, the side walls of the tank, above the level of the molten glass, are formed of burner blocks provided with horizontal gas ports and inclined air ports in communication with the regenerators. The blocks are provided with projections and also recesses, and also with projections to support the air and gas flues.

IMPROVED OIL-FIRED FURNACE.—A. A. Mohn (*Pat. J.*, 1,643, 1920). No. 143,094, July 11, 1919. Details are given of improvements in oil-fired melting furnaces for glass, etc., of the kind having a burner at one end, a working chamber at the other, and outlets to the chimney in the side walls. The working chamber is made higher and wider than the burner end of the furnace. The furnace is carried on longitudinal beams of concrete or reinforced concrete.

GLASS FURNACE.—H. Wilkinson (*Pat. J.*, 1,643, 1920). No. 143,125, Nov. 10, 1919. An illustrated description of a glass furnace having a grate just beneath the eye as in the old English type, and a recuperator from which heated secondary air is introduced to the eye through a passage.

DELIVERING APPARATUS.—S. D. Olsen (*Pat. J.*, 1,645, 1920). No. 143,606, Feb. 22, 1919. Relates to apparatus for charging parison moulds, mounted on a rotating table, from a tank. The stream of molten metal is cut into charges by shears. Each charge drops into a trough, which is oscillated by a cam and levers. The charge is laid out in a strip in the trough and is then shot into a mould.

DELIVERING GLASS.—H. C. Daubenspeck (*Pat. J.*, 1,669, 1921). No. 153,339, May 8, 1919. The molten metal is delivered through an outlet—the rate of flow being controlled by a valve—and is allowed to run continuously. The stream is cut by pneumatically-actuated shears having an exceedingly rapid action, so that the flow is not checked. The shears are placed close up to the outlet and consist of arms carrying blades. The severed charge falls into a mould which is brought close under the shears. In a modification the molten metal is discharged horizontally, the shears being arranged in a vertical plane. The furnace is provided with blowpipe inlets to maintain the temperature of the glass.

GLASS BLOWERS.—W. J. Jackson (*Pat. J.*, 1,642, 1920). No. 142,765, Dec. 31, 1919. A description of a glass-blowing machine of the type having blowpipes or spindles, which are rotated on their own axes at a low speed during the preliminary blowing of the blank.

PLATE GLASS MANUFACTURE.—J. Ramsey (*Pat. J.*, 1,664, 1920). No. 151,543, Description of apparatus for making sheet and plate glass.

GLASS FURNACE.—W. J. Miller (*Pat. J.*, 1,664, 1920). No. 151,605, Sept. 13, 1920. Relates to automatic pneumatically operated apparatus for delivering uniform charges of glass from a tank furnace.

GLASS MOULD MACHINE.—W. J. Miller (*Pat. J.*, 1,664, 1920). No. 151,606, Sept. 13, 1920. Relates to rotary paste mould machines in which the blowpipe with gather on the end is placed in the machine by hand.

FINISHING LAMP BULBS.—Br. Thompson-Houston Co. (*Pat. J.*, 1,665, 1920). No. 151,771, July 25, 1919. Description of a machine for stripping the bulb from the blowpipe, loading the bulbs into holders, removing the moil from the bulb and for smoothing the neck, so that it is ready to be made up into a lamp.

IMPROVED OWENS MACHINE.—W. E. Evans (*Pat. J.*, 1,665, 1920). No. 151,831, Oct. 16, 1919. Relates to improvements in automatic bottle-blowing machines of the Owens type, the object being to give additional support to the blank and to eliminate marks in the finished article caused by the cut-off knife.

DELIVERING MOLTEN GLASS.—R. T. McGee (*Pat. J.*, 1,663, 1920). No. 151,149, Aug. 28, 1916. Relates to apparatus for delivering molten glass from a tank to the moulds of a machine.

GLASS-MELTING FURNACE.—L. Mount (*Pat. J.*, 1,663, 1920). No. 151,184, Nov. 28, 1919. The glass outlets are formed in raised portions of the tank bottom near the recuperator, thus permitting the moulds of a glass-bottle machine to be positioned beneath them.

DRAWING GLASS CYLINDERS.—E. C. R. Marks (*Pat. J.*, 1,664, 1920). No. 151,361, June 23, 1919. Relates to a bait for drawing glass cylinders, having movable portions to allow for the contraction of the glass and to release the finished cylinder. The bait is charged with molten metal by suction.

SORTING GLASS RODS.—E. C. R. Marks (*Pat. J.*, 1,664, 1920). No. 151,486, Apr. 22, 1919. Relates to a machine for automatically sorting glass rods, tubes, etc., according to their diameters and weights.

MAKING CARBOYS.—H. Wade (*Pat. J.*, 1,664, 1920). No. 151,538, Mar. 4, 1920. Relates to a machine for making the necks of carboys and large glass containers with internally screwed mouths.

POLISHING GLASSWARE.—R. Haddan (*Pat. J.*, 1,660, 1920). No. 149,888, Feb. 14, 1920. Description of an apparatus for fire-polishing pressed glassware before it is removed from the moulds. It consists of a burner having a primary mixing-chamber and a secondary mixing-chamber, and adapted to receive the glassware to be polished. Means are provided for deflecting the combustible mixture from the burner to produce a swirling effect inside the bell. The device can be used for finishing the edge of ware formed of hard glass.

RECEPTACLES FOR BLOW-IRONS.—A. J. H. Haddan (*Pat. J.*, 1,661, 1920). No. 150,240, Mar. 1, 1920. Description of an appliance for receiving blow-irons after use, which is arranged so that the irons are delivered one by one for re-use and are retained in proper order.

COATING GLASS SURFACES. Br. Thomson-Houston Co. (*Pat. J.*, 1,662, 1920). No. 150,598, Jan. 8, 1920. Electric light globes may be dulled by applying a coating consisting of sodium silicate, French chalk, water, and a pigment, and then, when dry, covering with a water-proofing-mixture of Dammar varnish made very thin with turpentine. An opal appearance is obtained by using zinc oxide as a pigment, and the paint is made up with rather less water than when coloured pigments, such as sienna, are used. The glass surface may be sand-blasted before the first coating is applied, and

other forms of hydrous magnesium may be employed in lieu of French chalk. Designs can be produced by dissolving portions of the first coating with acids and then covering with the varnish.

DELIVERY FROM GLASS FURNACES.—J. Wolf (*Pat. J.*, 1,657, 1920). No. 148,556, July 10, 1920. Relates to a method of controlling the delivery of successive uniform charges of molten glass from the opening of a tank.

DELIVERING MOLTEN-METAL. O. M. Tucker, W. A. Reeves & J. M. Beatty (*Pat. J.*, 1,658, 1920). No. 148,848, July 10, 1920. For delivering uniform charges, the flow from the orifice is controlled by a cup, into which compressed air or a combustible mixture is introduced.

GLASS-BLOWING.—H. C. Daubenspeck (*Pat. J.*, 1,659, 1920). No. 149,402. May 8, 1919. A device for transferring automatically the parisons from the parison moulds to the finishing moulds of a bottle-making machine.

MOULDING GLASS.—L. Mount (Pat. *J*, 1,660, 1920). No. 149,757, May 16, 1919. Relates to apparatus for pressing glass or other plastic material into open-ended articles of cylindrical or other form, *e.g.*, miners' lamp glasses.

BOTTLE-MAKING MACHINE.—Wilzin Automatic Bottle-Making Machine Co. (*Pat. J.*, 1,662, 1920). No. 150,679, Aug. 17, 1920. Relates to automatic cam-operated bottle-blowing machines and includes apparatus for gathering the molten metal.

GLASS MANUFACTURE.—Wilcox Machine Co. (*Pat. J.*, 1,655, 1920). No. 147,635, July 8, 1920. Relates to a three-unit automatic machine for blowing bottles, moulding under pressure, removing articles from moulds, and shearing.

COLOURED GLASS.—K. Warga (*Pat. J.*, 1,657, 1920). No. 148,304, July 9, 1920. Coloured designs on glass surfaces are obtained by fusing the colours on at one operation. Designs are formed of fusible mineral colours and are built up in successive layers on transfer paper. The complete design is then transferred to the glass surface and fired at a gradually increasing temperature until it is completely fused on. The layers are composed of materials which melt at successive temperatures, the layer next the glass melting first and the outer layer last. The temperature at which the last layer melts is about 100°C. below the melting-point of the glass.

GLASS FURNACE.—Soc. An. Verreries de Fauquez (*Pat. J.*, 1,657, 1920). No. 148,490, July 10, 1920. In a bottle-glass furnace, the melting chamber, gas-producer and reversible regenerators are combined in one structure. The generator chambers extend beneath the hearth and the masonry separating the melting-chamber and producer, and communicate with the ports through verticle flues.

MOULDING GLASS UNDER PRESSURE.—H. C. Daubenspeck & S. E. Winder (*Pat. J.*, 1,652, 1920). No. 146,602, Apr. 8, 1919. In a machine for making pressed glassware in which the moulds are carried on a rotating table, the plunger is operated through an adjustable pneumatic cushioning-device. The molten metal flows continuously from a tank and is separated into charges by pneumatically-operated water-cooled shears. The machine is moved towards or away from the tank by pneumatic power when desired.

GLASS SHEARS.—W. J. Jackson (*Pat. J.*, 1,652, 1920). No. 146,617, Apr. 10, 1919. An arrangement whereby the shears sever the stream of glass without supporting it.

REMOVING BUBBLES FROM MOLTEN GLASS.—Schott & Gen (*Pat. J.*, 1,655, 1920). No. 147,487, July 8, 1920. Bubbles in the metal are reduced in size or entirely eliminated by subjecting the glass while in a soft state to a pressure of at least 200 at., so that the gases in the bubbles are absorbed.

SHEARING MOLTEN METAL.—O. M. Tucker & W. Reeves (*Pat. J.*, 1,655, 1920). No. 147,567, July 8, 1920. The molten metal is delivered into

travelling moulds from an orfice, which is closed periodically by a pneumatically-operated water-cooled blade. The weight of the charges can be altered without varying the speed of the machine.

GLASS MANUFACTURE.—E. Danner (*Pat. J.*, 1,684, 1921). No. 159,114, May 26, 1920. Molten glass flows in a flat stream from a tank under a regulating gate on to the top of a slab where the stream divides, the major portion flowing down the front of the slab and the minor part down the rear face. At the tip of the slab, the two flat streams unite and are drawn away as a single sheet having a high polish on both sides. The slab is disposed in a heated chamber.

REMOVING ARTICLES FROM THE BLOW-IRON.—R. Haddon (*Pat. J.*, 1,680, 1921). No. 157,653, Feb. 9, 1920. Relates to a device for removing a glass bulb from the blow-iron, the moil also being removed.

GASEOUS OR LIQUID-FUEL FURNACES.—C. Tonel (*Pat. J.*, 1,681, 1921). No. 157,684, June 15, 1920. In a glass-melting furnace using gaseous or liquid fuel, the burners and the passages leading to the flues are placed at the same level and at the same end of the furnace.

PRESS-MOULDING MACHINE.—H. C. Daubenspeck & S. E. Winder (*Pat. J.*, 1,683, 1921). No. 158,711, Nov. 12, 1919. A modification of the machine described in Spec. 146,602. The plunger is operated by a pneumatic cylinder and piston instead of by a cam-and-lever device.

AUTOMATIC BOTTLE-BLOWING MACHINE.—G. O. Tague (*Pat. J.*, 1,684, 1921). No. 158,949, Oct. 16, 1919. The device for transferring the parisons to the blowing moulds mounted on a rotary table, is provided with 4 arms mounted on a shaft, which is raised and lowered and rotated intermittingly in unison with the tables by cam mechanism on the main shaft. Each arm is fitted with a pair of pivoted grippers, which are opened and closed by toggles.

SPUN GLASS.—C. Muth (*Pat. J.*, 1,677, 1921). No. 156,202, Jan. 3, 1921. Glass is softened in a heated vessel, forced by pressure through fine apertures and then spun into threads and reeled up as usual.

GLASS MANUFACTURE.—W. J. Miller (*Pat. J.*, 1,677, 1921). No. 156,569, Sept. 24, 1920. Relates to a press and blow machine of the cam operated, rotary-table, turnover parison type.

DELIVERING MOLTEN GLASS.—Hartford-Fairmont Co. (*Pat. J.*, 1679, 1921). Nos. 157,159/60. Relates to the delivery of uniform charges of molten glass from a tank, and to shaping same.

SPUN GLASS.—G. Pazsiezky (*Pat. J.*, 1,680, 1921). No. 157,360, Jan. 10, 1921. The end of a glass rod is heated by a burner until a drop of glass forms and falls on to a rotating drum, to which it adheres and draws out a thread.

DRAWING SHEET GLASS.—R. L. Frink (*Pat. J.*, 1,680, 1921). No. 157,598, Nov. 6, 1919. To promote the adhesion of the bait to sheet glass during drawing, it is heated by an electric current supplied to it through a transformer and leads. Electrically heated fingers engage the edges of the sheet near the drawing point and prevent the contraction of the sheet in width.

GRINDING AND POLISHING PLATE-GLASS.—Pilkington Bros. (*Pat. J.*, 1,672, 1921). No. 154,661, July 31st, 1919. Glass plates are mounted for grinding and polishing on rectangular tables adapted to be passed in a series, with their adjacent ends in contact, beneath sets of runners each supplied with a particular grade of abrasive.

BOTTLE-BLOWING MACHINE.—Wilzin Autom. Bottle-Blowing Mach. Co. (*Pat. J.*, 1,672, 1921). No. 154,915, Aug. 17, 1920. The invention, which relates to automatic cam-operated machines, consists in the arrangement and operation of the moulds and apparatus immediately connected with them. A gathering iron descends into the metal in a tank and, on rising again, the

falling metal from it is caught by a cup provided with an overflow spout to ensure a constant level of metal in it.

DELIVERING MOLTEN METAL.—J. D. Roots (*Pat. J.*, 1,676, 1921). No. 155,922, Oct. 3., 1919. In apparatus for delivering uniform charges of molten glass from a tank furnace, the plunger, reciprocated above the discharge hole, is of hollow cylindrical form. The air is initially drawn out of the hollow plunger, and during the upward stroke, a vacuum is formed, or tends to be formed within it.

GLASS FURNACE.—A. Ferguson (*Pat. J.*, 1,671, 1921). No. 154,251. May 28, 1919. The materials are melted and react on one another in a chamber of trumpet form, in which they are subjected to the whirling action of the burning gas and air jets introduced through openings at the top. The molten glass flows down the sides of this chamber into a tank, where it is refined under the action of the combustion products from the first chamber.

AUTOMATIC BOTTLE-BLOWING MACHINE.—A. Ferguson (*Pat. J.*, 1,671, 1921). No. 154,252, May 28, 1919. The machine gathers the molten metal from the fore-hearth of a tank furnace and delivers the finished bottle on to a conveyer. A number of gathering cylinders are mounted to rotate in a verticle plane so as to dip successively into molten metal in the tank.

GLASS CYLINDERS.—E. C. R. Marks (*Pat. J.*, 1,671, 1921). No. 154,354, Sept. 3, 1919. Description of apparatus for drawing glass cylinders.

CUTTING GLASS.—C. Zeiss (*Pat. J.*, 1,672, 1921). No. 154,577, Nov. 3, 1920. Relates to machines, with rotary tables, for cutting non-circular glasses, particularly spectacle lenses.

BOTTLE-BLOWING MACHINES.—S. E. Winder (*Pat. J.*, 1,667, 1920). No. 152,414, July 12, 1919. In bottle-blowing and similar machines, in which the parison moulds and blowing moulds are mounted on separate rotating tables, a gripper transfer device is used to transfer the blank from a solid undivided parison mould to the blowing mould.

MOULDS.—A. J. H. Haddon (*Pat. J.*, 1,667, 1920). No. 152,567, Mar 2, 1920. Description of a mould for blanks from which lens-fronted thermometers are made.

MAKING CARBOYS, ETC.—H. Wade (*Pat. J.*, 1,667, 1920). No. 152,569. Mar. 4, 1920. Relates to a machine for making the necks of carboys and large glass containers.

BOTTLE-BLOWING MACHINE.—W. J. Miller (*Pat. J.*, 1,667, 1920). No. 152,597, Sept. 24, 1920. A semi-automatic double rotating table machine operated pneumatically.

ARTIFICIAL STONE.—P. B. Crossley (*Pat. J.*, 1,668, 1920). No. 152,780, July 22, 1919. Non-fragile glass, which can be rolled, forged, extruded, cast, etc., is made by dissolving in the dry state such silicates as micaceous or asbestos minerals in molten glass or similar silicate. The glass is chosen so as to melt below the temp. at which the mica, etc., effloresce. If the product is to be machined, an excess of mica should be present over the amount required for a saturated solution.

THE SILICA-GLASS INDUSTRY.—G. Flusin (*Chim. Ind.*, **5**, 119, 1921). A general survey of the subject, with numerous photographic and diagrammatic illustrations of furnaces, workshops, etc. The article opens with short reviews of the historical development of the industry in England, Germany, France, Switzerland and the U.S.A. The present foreign makers of silica glass are : The Heraeus Co., at Hanau (transparent variety), and the Deutsch-Englische Quarzschmelze at Pankow, in Germany ; the Société Le Quartz Fondu at Argentière-la-Bessée, in France ; and the Sidio Company and the General Ceramics Co. in America. The various methods of fusing and making *opaque silica-glass* are discussed in detail. As a raw material, rock crystal is too expensive for making opaque glass. Chemically pure

glass sand was found by Brown & Hutton in 1902 to give satisfactory results. A good sand should analyse approximately as follows: SiO_2 99·57%, Al_2O_3+ Fe_2O_3 0·15%, CaO 0·10% and MgO 0·08%. Organic matter should not be present in any appreciable quantity, and the grains should, as far as possible, be of uniform size. Deposits of sand fulfilling these requirements are not very numerous ; those near Fontainebleau are particularly valuable. In the preparation of the sand, drying—sometimes preceded by washing—is resorted to at the works. The electric furnaces at present in use do not differ in essentials from the Bottomley-Paget type (illustrated). At first, the current passing through the furnace is relatively weak ; with a resistor 70 cm. long and 2 cm. diameter it does not exceed 300 amperes. But since the resistance of the carbon rod diminishes with a rise in temperature, the strength increases progressively to 1000—1500 amp., according to the size of the resistor. The sand in the immediate vicinity of the carbon first becomes fused, forming a sort of plastic layer round the resistor. This layer increases in thickness as the sand further from the resistor fuses. But, both from the physical and chemical point of view, the fusion process is much more complex than this simple explanation would imply. As soon as the resistor reaches red heat, the air and moisture in the sand react with it, giving carbon monoxide and hydrogen. At 1400—1450°C. the hydrogen and the carbon reduce the silica, and the silicon formed has then reached its fusion point (1430°). At 1600° the silicon begins to volatilize and condenses in the coldest parts of the charge, becoming oxidised if sufficient oxygen is present. Beyond 1470° the quartz is transformed into amorphous silica, but retains its hardness. The silica softens at 1650° ; the grains of sand near the resistor agglomorate, but voids are formed between them, permitting the free passage of gases. At this temperature, amorphous silicon carbide is formed, and the resistor is attacked superficially. At 1750° the vaporization of the silica comes into play ; it condenses in the cooler parts of the charge, its latent heat of vaporization contributing to raise the temperature there. Furthermore, it cements the grains together, fills the pores, and leads to the formation of a tube of impermeable and plastic amorphous silica round, and in immediate contact with, the resistor. Between 1750 and 1800° the silica becomes really plastic. It reacts more vigorously with the carbon of the resistor, and the larger volume of CO produced, which can no longer escape through the pores of the charge, exerts pressure on the fused mass, causing it to lose contact with the resistor, from which it becomes finally separated by an annular space. This hollow cylindrical form assumed by the fused silica greatly assists later operations of forming, etc. The time taken by the fusing process naturally depends upon the size of the tube of silica to be produced ; for pieces of average weight it requires from 30 to 45 minutes. The average consumption of electric energy is given as 1500 kw. h. per ton of silica. The theoretical consumption, calculated solely for heating and fusing the silica, is about 850 kw. h. per ton, so that the mean efficiency of the furnace may be put down at about 57%. The usual methods of forming and finishing the pieces are described in some detail. For the manufacture of the *semi-translucent variety*, three processes may be employed : (1) the opaque glass may be submitted to more intensive scouring to remove the outer crust of quartz grains. Better results are obtained by treating the piece with hydrofluoric acid or with alkalies. (2) a carbon cylinder, concentric with the resistor, is placed in the furnace. If the operation is prolonged until complete fusion of the sand filling the annular space between the resistor and the carbon cylinder takes place, both the outer and inner surfaces of the silica tube produced will be smooth and glossy, and free from quartz grains. (3) re-fusion is the third and best method of producing semi-translucent glass. The opacity of a piece of silica glass—due to the presence in it of innumerable minute bubbles—can be reduced considerably by a subjecting the glass to a rapid and intense heating. For small objects the process can be carried out by means of the oxihydrogen flame or voltaic arc. Larger pieces are treated in the Bottomley and Paget auxiliary electric furnace. *Transparent silica-glass.* The raw material for this variety is Brazilian or Madagascar rock crystal.

Day & Shepherd showed that the presence of 0·3% of impurities was sufficient to render the glass opaque, or at any rate to produce dark patches in places. The quartz, which should contain from 99·6 to 99·8% SiO_2, is heated above 570° and then immersed in water. It is then reduced to small grains, purified with acids, washed and dried. Madagascar crystal thus treated gives 99·66% SiO_2, 0·09 $Al_2O_3+Fe_2O_3$, 0·09 CaO and 0·07 MgO. One of the principal difficulties in fusing quartz in a compact, transparent mass, namely, that of finding a material for the pots which is not attacked by the fused silica, may be considered as solved. Hitherto zirconia, and any one of the various carbides of silicon (carborundum, silfrax, silundum, silite, etc.) have been found most suitable for this purpose. Another, and more serious problem is how to remove the enclosed air bubbles. These may be due to the air between the grains of the charge before fusion, or to the transformation into β-quartz which takes place at 575°, and is accompanied with an abrupt increase in volume of about 1%. The Heraeus, Herschkowitsch, Bredel & Day-Shepherd methods of firing the glass are briefly discussed. Day & Shepherd succeeded in obtaining sheets measuring 76 × 126 × 12 mm., almost entirely free of seeds, by the following process: The charge is rapidly brought to a temperature of 2000°, the interior of the furnace being open to the air, so that fusion and an intense vaporization of the silica take place simultaneously, the silica vapours expelling the air bubbles. After a short time, the furnace is put under a pressure of 35 at. and the temperature lowered to 1800°; after half an hour the silica-glass runs into a compact, transparent mass, and the pressure can be gradually decreased. The relative advantages of pure fused silica and the "siloxides" are discussed in some detail. The article closes with an account of the various uses to which silica glass may be put, and a list of 81 patents and 35 bibliographical references dealing with the subject are appended.

VI.—CEMENT, CONCRETE, MORTARS, ETC.

TRASS AND PORTLAND CEMENT.—G. Fredl (*Tonind. Ztg.*, **44**, 1123, 1920). The addition of finely powdered material to cement is generally held to increase the strength by raising the density. The crushing strength, however, can only be increased, if the material added contains matter which is capable of entering into chemical combination with the other ingredients. Michaelis showed that rock crystal, ground to the finest powder, gave a jelly-like mass with lime-water. The addition of trass is more effective with cements having a high lime content than with those containing less lime. The quantity added, however, should not exceed the amount required to react with the lime present.

THE EFFECT OF FUEL OILS ON CONCRETE.—A. Guttmann (*Tonind. Ztg.*, **44**, 1116, 1920). Tests carried out by G. for the German Admiralty showed that concrete was by no means immune from attack by fuel oils, unless it undergoes special treatment. The test cubes were allowed to set for 7 days in the air and were then given a coating of waterglass. Different samples were then given further setting periods in air, in petroleum and in coal tar oil, and the following figures for crushing strength were obtained:—

	In air at room temp.		In petroleum		In coal tar oil	
	28 days	6 mts.	28 days	6 mts.	28 days	6 mts.
Cement G	210	192	168	185*	160	158‡
,, K	287	272	242	252*	216	249‡
,, R	262	288	193	238*	191	189‡

* The oil had penetrated into samples to about 5 mm.
‡ The samples were completely saturated with oil.

The writer invented a process which rendered the concrete impermeable to oils and also prevented the latter from reducing the crushing strength.

"LEUKOLITH," A MORTAR MADE FROM ANHYDRITE.—H. E. Sachse (*Tonind. Ztg.*, **44**, 1017, 1920). Experiments carried out by F. Hartners led to the discovery that anhydrite would set, under certain conditions, within a few hours. It must be ground to extreme fineness, or, alternatively, the mixture of the powder with water must give an alkaline reaction. The addition of a small quantity of lime (1—3%) gives a very rapid and satisfactory setting.

CONCRETE TANKS FOR AMMONIA WATER.—Grossheim (*Tonind. Ztg.*, **44**, 1062, 1920). On examining a concrete tank, measuring $7 \times 5 \times 1\frac{1}{2}$ metres, which had been used as a container for ammonia since 1905, it was found that the inner lining had not been affected in the least. A crack had formed on the outside, into which the ammonia water penetrated, causing the iron to rust; the concrete, however, remained perfectly intact. With good materials and careful workmanship, therefore, reinforced concrete proves an excellent material for ammonia containers.

THE "GRIPPING" PROPERTY OF CONCRETE ON IRON.—W. T. (*Tonind. Ztg.*, **44**, 968, 1920). A short discussion of V. Karpens' paper published in "Le Génie Civil."

THE INFLUENCE OF MORTAR ON WALL STRENGTH.—Sasse (*Tonind. Ztg.*, **44**, 969, 1920). The following figures (mean values) indicate the results obtained with different mortars.

Composition of Mortar.			Wall strength.
1 lime paste,	1 trass,	1 sand	54% of brick strength.
1 ,,	1 ,,	2 ,,	53% ,, ,, ,,
1 ,,	$1\frac{1}{2}$,,	2 ,,	75% ,, ,, ,,
1 cement,	1 lime,	6 sand,	75% ,, ,, ,,
1 ,,	1 ,,	8 ,,	75% ,, ,, ,,
1 ,,	2 ,,	8 ,,	65% ,, ,, ,,
1 ,,	$\frac{1}{2}$,,	4 ,,	92% ,, ,, ,,
1 ,,	$\frac{1}{2}$,,	6 ,,	78% ,, ,, ,,
1 ,,	4 sand		90% ,, ,, ,,
1 ,,	6 ,,		79% ,, ,, ,,

The investigation was carried out by Prof. Quietmeyer, Hannover.

IMPERMEABLE CEMENT PIPES.—(*Tonind. Ztg.*, **44**, 878, 1920). A short account of a Danish invention, the information being taken from the "*Berlingske Tidende.*" The pipes are dipped in an impregnating mixture for a few minutes, and receive a black, impermeable coating both on the inner and outer surfaces. The mixture penetrates several mm. into the cement, and microscopic examination shows that each grain of cement is covered with a film of the mixture. The coating dries at once, and the pipes are then ready for use. The durability of the pipes is increased rather than diminished by this treatment.

THE EFFECT OF ACIDS ON CONCRETE.—(*Tonind. Ztg.*, **44**, 573, 1920). The writer disputes the statement that acid solutions containing less than 0·1% are practically harmless. Even if only traces of acid are present, a protective coating on the concrete is essential.

GYPSUM AS SUBSTITUTE FOR PUTTY.—G. Atterburg (*Tonind. Ztg.*, **44**, 871, 1920). A slow-setting plaster has been used successfully by the writer in place of the ordinary putty mixed with linseed oil. Ordinary model plaster can be rendered slow-binding by the addition of glue. During the war, cement was also tried for this purpose, but it was found too injurious to the hands.

TRASS AS A CEMENT SAVER.—H. Sachse (*Tonind. Ztg.*, **44**, 831, 1920). Tests were carried out on blocks measuring $7 \times 7 \times 7$ cm., containing varying proportions of cement, gravel and trass. The composition of the trass was as follows: 56·05% SiO_2, 22·58% $Al_2O_3 + Fe_2O_3$, 2·71% CaO, 1·43% MgO,

trace of SO_3, 7·94% $Na_2O + K_2O$, 2·83% hygroscopic water, 6·47% chemically combined water. The test blocks containing trass invariably showed greater mechanical strength than those containing the same quantity of cement and no trass.

ARTIFICIAL MARBLE.—K. Haerting (*Tonind. Ztg.*, **44**, 894, 1920). As a binder for artificial marble, either Portland cement, gypsum or magnesia cement may be used, but cement gives a product which is much more resistant to dampness and weather. To ensure a good appearance of this latter type, the addition of powdered marble, fine marble sand and powdered quartz is essential. A fine, cloudy graining effect is obtained if the body is worked up to syrup consistency and the colouring matter then added and gently stirred. The stamped or pressed blocks must be allowed to set in a fairly damp place, maintained at an even temperature. Draughts must be avoided at all costs. Polishing may be undertaken after about a week.

BEHAVIOUR OF ULTRAMARINE IN CEMENT.—K. Haerting (*Tonind. Ztg.*, **43**, 735, 1919). Blocks made of rather coarse, sandy mortar, the outer surfaces of which were coloured blue and green with ultramarine, were found to develop layers of fine, needle-shaped crystals, which, on careful analysis, proved to be almost pure sodium sulphate. After a period of about 6 years, the blocks were entirely decolorised with the exception of the thin outer layer. It is supposed, therefore, that, under the powerful pressure and other influences, such as rapid variations in temperature, the sulphur content of the ultramarine reacts slowly with the cement and the salts contained in it, finally crystallising out as sodium sulphate. At the surface, heat and especially light, appear to have a preserving effect. On the other hand, cement plates coloured green with a mixture of bright ultramarine blue and bright yellow ochre, when used for floor paving, turned a dirty yellow colour in the sun, but retained the green colour in the shade. The theory is put forward that ultramarine must be considered as a definite solution, the particular colour depending upon the degree of the dispersity of sulphur, just as the colour of colloidal gold solutions varies with the degree of dispersity of the gold particles.

CEMENT REFUSE-BINS.—Anon. (*Tonind. Ztg.*, **43**, 803, 1919). The cubical contents of cement dust-bins should not be more than from 1 to $1\frac{1}{4}$ cu. metres. The bottom is about 3 cm. thick, with a wire gauze core, which is joined to similar cores running through the sides.

SIMPLE APPARATUS FOR TESTING CEMENT.—R. Grün (*Tonind. Ztg.*, **43**, 871, 1919). The apparatus for making the breakage test consists simply of a circular container, into which shot is poured. This is suspended from the centre of the test bar. The average breaking strain on 10 bars, tested 24 hours after making, was 2320 grs.

BLAST-FURNACE CEMENT GOODS.—H. Passow (*Tonind. Ztg.*, **43**, 873, 1919). Blast-furnace cement sets slowly, so that articles made from it must be allowed to remain in the moulds somewhat longer than is the case with other varieties. It is also more finely ground, and this increases the tendency to crazing due to shrinkage. This trouble can be avoided by adding screened sand.

REINFORCED CONCRETE STAIRCASE WITH HOLLOW STEPS.—Gaehme (*Tonind. Ztg.*, **43**, 887, 1919).

CEMENT PALISADES.—Anon. (*Tonind. Ztg.*, **43**, 897, 1919). A short article with illustration and diagrams.

CONCRETE "BOX" BRICKS.—Anon (*Tonind. Ztg.*, **43**, 930, 1919). The brick described (and illustrated), measures $50 \times 25 \times 25$ cm. It differs from other forms of hollow blocks in that it is box-shaped, *i.e.*, open at one side. This open side is so shaped as to make a good joint with the block below in wall construction.

CEMENT ROOFING TILES.—Anon. (*Tonind. Ztg.*, **43**, 939, 1919). The writer puts forward several reasons why the manufacture of tiles should not be undertaken on the building site.

CENTRIFUGAL MACHINE FOR CEMENT PIPES.—W. T. (*Tonind. Ztg.*, **43,** 1035, 1919). A short description, with sketches, of a machine, manufactured by the French firm Moir et Buchanan, for making cement pipes with a diameter of from 150 to 375 mm.

FERRO-CONCRETE "MATS" FOR CANAL CONSTRUCTION.—Anon. (*Tonind. Ztg.*, **43,** 1055, 1919). Professor Franzins suggests that the usual clay bed might be replaced by thin concrete "mats" in dangerous sections. The mats would be about 5 cm. thick and would be cast on the spot. In view of the experience gained in ferro-concrete ship-building, Franzins claims that the mats would be sufficiently elastic to follow the sinking movement of the banks.

DOCK GATES OF FERRO-CONCRETE.—(*Tonind. Ztg.*, **43,** 1185, 1919). A short account of work carried out for the British Admiralty during the war by a Tilbury firm.

FERRO-CONCRETE SNOW SCREENS FOR RAILWAYS.—A. Weigert (*Tonind. Ztg.*, **43,** 1192—3, 1203, 1215—6, 1234—5, 1919). Methods of construction and of calculating the required dimensions are discussed in some detail.

FERRO-CONCRETE SHIPBUILDING.—Anon. (*Tonind. Ztg.*, **43,** 1242, 1919). A review of a book on the subject by M. Rüdiger.

A METHOD OF APPLYING METALLIC COATINGS TO ARTIFICIAL STONE.—Schonlau, Germ. Pat. 288,435, Welte (*Tonwar. Ofen. Ztg.*, **43,** 131, 1919). After several years' work, Welte succeeded in applying a coating of metal to asbestos-cement plates which is absolutely water and frost proof and adheres firmly to the stone. Before being placed under the hydraulic press, the plates are covered with a surface layer of metallic powder—any kind may be used—and by the application of pressure the metallic powder forms a uniform layer with the body. Sheets, bricks, and pipes can be made of this material, so that it has a wide application.

RESISTANT AND NON-ACTINIC PAINT FOR CEMENT.—E. Blondel (*Cer.*, **22,** 166, 1919). With the object of rendering objects less conspicuous from the air during wartime, a mineral paint of great durability and only slightly actinic was applied to structures made of cement impregnated with milk of lime. The substance used was a basic sulphate of chromium, in using which the effect is to precipitate the green oxide of chromium associated with calcium sulphate in the pores of the cement. This treatment gives to the cement a more impermeable surface and a greenish tint, which is not affected by air or water. The paint is prepared as follows :—A solution is made up of 0·3 grs. bichromate of soda, 0·14 grs. sulphuric acid (66°Bé.) and 0·2 grs. water, to which 70 cc. of glycerine are added drop by drop, the whole being well shaken until reduction is complete. The solution is then made up to 1 litre with water and allowed to cool, so that the crystals of sodium sulphate may separate out. On making up to 3 litres, the density of which corresponds to 10°Bé., the paint is ready for use. The reduction may be carried out industrially in a more economic way by treating the bichromate solution directly with SO_2, or even with bisulphite of soda. In the latter case it is advisable to acidify the chromic solution slightly, in order to avoid precipitation of the oxide of chromium. The best results are obtained if the cement surface is first brushed, washed over with a coating of milk of lime and allowed to dry. The paint can then be applied with a brush.

MORTAR SPRAYING MACHINES.—Anon. (*Tonind. Ztg.*, **43,** 1307, 1919). A short historical survey taken from an article in "Génie Civil."

THE MANUFACTURE OF HYDRAULIC LIME AND NATURAL CEMENT.—G. Lefevre (*Cer.*, **22,** 1—5, 1919). A short, general account of the modern process. The article is illustrated.

FERRO-CONCRETE SHIPBUILDING.—Anon (*Tonind. Ztg.*, **43**, 1326, 1919). According to Teubert, an iron ship of 1000 tons total capacity would have a displacement of 1450 tons and would measure 55 m. in length, 8 m. beam and 4·5 m. depth. A concrete ship of the same capacity would be 59 m. long, 8·8 m. beam and 5·5 m. in depth, with a displacement of 1850 t. Experts differ considerably, however, as to the relative dimensions.

FERRO-CONCRETE TILE ROOFS.—E. Neupert (*Tonind. Ztg.*, **44**, 548, 1920). An illustrated description of roof constructiou without wooden supports.

SUBSTITUTES FOR CEMENT.—C. Platzmann (*Tonind. Ztg.*, **44**, 697, 1920). The great majority of the cement substitutes at present on the market must be considered as frauds. An exception to this, however, is a substance known as "*Silikalit*," supplied by the Sächs-Böhmischen Portlandzementfabrik, with the following chemical composition: silica 22·93%, alumina and iron oxide 10·33%, lime 57·64%, magnesia 0·98%, sulphurous sulphur 0·03%, sulphuric anhydride 3·65%, alkalies 1·20%, loss on ignition 3·15%. The crushing strength of this material is such as to render it quite suitable for all building purposes.

ARTIFICIAL MARBLE.—P. J. Guillot (*Pat. J.*, 1,649, 1920. No. 145,443, June 18, 1920. A mixture of 2 kilos of pure silicon and volcanic powder, 2 kilos of sea-water, 2 kilos pyromagnesic oxide, 270 grams cellulose reduced to the liquid state, 100 grams powdered Cape asbestos, 200 grams "tereline" (spirit of turpentine and linseed oil) and 100 grams colouring-matter is moulded under pressure and can be removed from the moulds in 10 hours.

CONCRETES AND MORTARS.—E. Link (*Pat. J.*, 1,650, 1920). No. 145,569, June 29, 1920. Blast-furnace slag is mixed with burnt earths rich in silica, such as brick-dust, clinker, chamotte, stone-ware, porcelain, and the mixture is finely ground to produce a substance similar to trass for use in mortar.

PROOFING CONCRETE, ETC.—J. Marcusson (*Pat. J*, 1,650, 1920). No. 145,673, June 30, 1920. Containers are rendered impermeable to oils and fats by coating them on the inside or on both sides with artificial resin, such as the product obtained by the action of formaldehyde or phenols, etc. This may be applied in the liquid state or in solution, or mixed with sand, kieselguhr, or other filling such as fibrous material, advantageously with the addition of lime or other basic material to hasten setting. Without the basic material, the coating is resistant to the action of acids.

CONCRETE.—W. J. de Bas (*Pat. J.*, 1,645, 1920). No. 143,768, Aug. 22, 1919. Micaceous iron ore is added to cement, lime or plaster in a moist condition to produce a composition of pleasing appearance. Colouring-matter may also be added. The amount of ore added may vary from 1 of ore to 10 of cement, etc., to 1 ore to 1 cement.

CASTING CONCRETE.—J. H. Harrison (*Pat. J.*, 1,647, 1920). No. 144,546, Oct. 27, 1919. Moulds for casting articles of concrete and like plastic material, of the kind provided with detachable liners which remain around the moulded article when the mould is withdrawn, are furnished with rollers or similar anti-friction devices carried either by the liners or the mould to facilitate removal of mould.

HARDENING ARTIFICIAL STONE. C. H. Schol (*Pat. J.*, 1,647, 1920). No. 144,706, June 10, 1920. Artificial stone is set and hardened by treatment with low-pressure steam which effects the preliminary set of the cement. The hardening may be completed in high or low-pressure steam. The stones may also be set by exposing them to the air and subsequently hardening in high pressure steam.

MOULDING CONCRETE.—T. J. McDowell (*Pat. J.*, 1,642, 1920). No. 142,595, Mar. 7, 1919. Relates to shaking or vibrating tables for consolidating

concrete in moulds.

CONCRETE FOR BUILDING BLOCKS.—G. A. Braven (*Pat. J.*, 1,643, 1920). No. 142,958, Mar. 1, 1919. The concrete consists of cement (or lime) 1 measure, breeze or furnace residue, clinker, ashes, etc., 3 to 4 measures, lime (or lime putty) 1 measure, with or without wood saw-dust ½ to 1 measure. For immediate use, the breeze and lime putty are ground together wet, and the cement mixed with water is ground in. Preferably, the breeze and lime mixture is allowed to stand 2 or 3 days before grinding in the cement, or the wet concrete should be kept for a like period before use. Slabs, etc., of the composition may be re-inforced.

BUILDING-BLOCKS.—Bells United Asbestos Co. ; J. A. Cann & E. Hurden (*Pat. J.*, 1,645, 1920). No. 143,691, Apr. 15, 1919. Blocks or slabs comprise a cement-concrete body furnished with a cement-asbestos face integrally united by applying one material to the other whilst both are in a freshly-made state and allowing to set. A mould is first lined with freshly-prepared cement-asbestos and then filled with cement-concrete and the whole allowed to set.

CONCRETE CHIMNEY FLUES.—E. W. Thomeley (*Pat. J.*, 1645, 1920). No. 143,692, Apr. 23, 1919. Flue holes in concrete and similar flue blocks are formed by pipes of fire-clay, which are cast in.

CONCRETE WALLS.—K. Yamaguchi (*Pat. J.*, 1,669, 1921). No. 153,417, Sept. 3, 1919. In shuttering for concrete walls each board comprises an outer part and an inner part or lining, consisting of detachable portions and a fixed part. The various parts are so constructed and arranged as to allow of ready removal.

ARTIFICIAL STONE.—J. Ward (*Pat. J.*, 1,669, 1921). No. 153,433, Sept. 25, 1919. The stone is made from a mixture of cement, Bath stone and slag, with a water-proofing agent consisting of lime, fat and an alkaline carbonate or bicarbonate and with or without bitumen.

MOULDING SLABS, ETC.—C. J. Ross (*Pat. J.*, 1,670, 1921). No. 153,491, Jan. 3, 1920. In making slabs, etc., of cement or concrete, the material is filled into moulds in a dry state and water is slowly introduced by capillary action. Ropes of asbestos or jute may be set at intervals into the mould, with their upper ends extending into a vessel containing water ; or a strip of fabric may be set against the side of the mould. Sticks of porous earthenware may also be used. When sufficient water has been introduced, the capillarity of the ducts is destroyed by charging them with an oily substance or by sealing the exposed ends, after cutting off the excess length, by applying thereto an unctuous or bituminous substance repellant to water.

MOULDING CONCRETE BLOCKS.—E. Lechat (*Pat. J.*, 1,670, 1921). No. 153,599, Nov. 11, 1919. Relates to the manufacture of faced concrete blocks and comprises apparatus for charging the moulds with body and facing materials. The apparatus can be operated by hand.

MOULDING HOLLOW BLOCKS.—G. Kuhn (*Pat. J.*, 1,642, 1920). No. 142,484, July 10, 1918). Relates to extrusion presses with a moving core or cores for making hollow blocks closed on all sides and consists in freely mounting the cores within the press head.

CONCRETE PIPES.—J. A. Glendinning (*Pat. J.*, 1,642, 1920). No. 142,487, Apr. 29, 1920. Highly resistant porous concrete pipes are made from a mixture of sharp-edged gravel or the like with cement and water, without sand, being stamped in moulds by means of tamping tools having knife-like or other pointed projections which penetrate the material, whereby the gravel particles are re-arranged with their flat surfaces relatively superposed.

MIXING CONCRETE.—H. P. Brown (*Pat. J.*, 1,669, 1921). No. 153,208, Mar. 10, 1919. Concrete is mixed with the proper amount of water in a closed vessel under pressure and heated preferably, thereby securing perfect hydration. The mass is then granulated by a fluid blast and conveyed through a

conduit to a nozzle through which it is discharged in placing. The pressure is obtained by the action of an elastic gaseous element such as superheated steam, which may also serve as the impelling force for discharge. The material may be acted upon by rotating blades in the vessel.

REINFORCED-CONCRETE PIPES, TUNNELS, ETC.—G. C. Bartram (*Pat. J.*, 1,669, 1921). No. 153,316, Nov. 2, 1920. In structures such as pipes, in which an imperforate metal sheet is embedded in concrete, tie means of holding the concrete, such as wires, are welded to the sheet. The wires may be double ended and attached at their mid-points. They may also be attached to a mesh-reinforcement by means of circumferential rings or coils. The invention is also applicable to tunnels, tanks, reservoirs, etc.

MOULDING BUILDING-BLOCKS.—K. Hessel (*Pat. J.*, 1,678, 1921). No. 156,761, Jan. 7, 1921. Description of a block machine.

MOULDING CONCRETE BLOCKS, ETC.—E. L. Warren & W. J. Parker (*Pat. J.*, 1,680, 1921). No. 157,510, Oct. 2, 1919. A machine for making concrete or breeze blocks comprises a timber framework supporting a table, from which depend moulds constructed of timber and provided with sheet-metal linings and false bottoms.

MOULDING HOLLOW CONCRETE BLOCKS.—E. Keel (*Pat. J.*, 1,680, 1921). No. 157,589, Nov. 5, 1919. Description of a machine.

CEMENT.—H. D. Baylor (*Pat. J.*, 1,682, 1921). No. 158,390. Nov. 8, 1919. Quick-setting cements are converted to slow-setting by the addition of 10—17% of quicklime and sufficient water to hydrate the lime produced by the decomposition of the aluminates, and also the added lime, the mass being agitated to prevent setting during the hydration, and finally re-ground. For instance, 1,650 lb. hydraulic cement is ground with 200 lb. lime, the mixture is agitated and about 150 lb. of water are added. When the reaction is complete, the mass is re-ground.

REINFORCED CONCRETE.—E. Maier (*Pat. J.*, 1,677, 1921). No. 156,551, Jan. 5, 1921. For hardening purposes, a reinforced block is subjected 3 days after moulding to steam at a pressure of 9 at. for 9 hours.

MOULDING CEMENT BLOCKS.—Aktiebolaget Lean (*Pat. J.*, 1,678, 1921). No. 156,619, Jan. 6, 1921. Description of a cement block machine, in which the moulds are movable vertically for discharge, the blocks being held down during the upward movement of the moulds by means of a locking-device acting upon the plungers until the blocks have been detached from the moulds.

WATERPROOFING CONCRETE.—K. Winkler (*Pat. J.*, 1,678, 1921). No. 156,621, Jan. 6, 1921. A waterproofing composition to be added in the proportion of about 1 kilo to 12 kilos of the gauging water for mortar, cement, concrete, etc., is made by mixing about 3 parts 10°Bé. potassium silicate solution with 2—2½ parts freshly made calcium chloride solution of 7—10°Bé., and mixing the colloid thus produced with 8—15% of its weight of pure dust-fine carbonate of lime, and 5—8% fat or oil emulsified with 7—18% potassium hydrate solution. Carbide mud may be used for carbonate of lime, chalk is unsuitable. Quick setting is obtained by increasing the proportion of calcium chloride, rapid hardening and water-tightness by increasing the pot. silicate, and improved adhesion by increasing the pot. hydrate. The proportion of fat, or oil, and lime carbonate must never be increased.

MOULDING CEMENT PIPES, ETC.—A. O. Crozier (*Pat. J.*, 1,668, 1920). No. 152,748, July 17, 1919. A column of cement mixture, of such a height as to effect by its own weight a compacting of the lower portion, is poured into an upright shaft. The lower part is cut off, or cut off and cut up, and removed. The remainder of the column then descends, and the shaft is filled up again.

MOULDING MACHINE FOR CONCRETE BLOCKS.—N. A. M. McDowell (*Pat. J.*, 1,671, 1921). No. 154,051, Oct. 28, 1919.

SLOW-SETTING CEMENT.—H. D. Baylor (*Pat. J.*, 1,674, 1921). No. 155,431, Nov. 8, 1919. Cement is rendered slow-setting, plastic, and waterproof by adding quick-lime and sufficient water to hydrate the aluminates and the calcium oxide formed by the decomposition of the aluminates, and also the lime added, and incorporating an unsaponifiable oily or waxy material during the hydration, and grinding the mixture. During the reaction the mixture is mechanically agitated. For instance, 1,620 lb. of cement are ground with 200 lb. quicklime and sufficient water is added to hydrate the added lime and to decompose and hydrate the aluminates in the cement. At the same time, 30 lb. of "slops" (residue of petroleum distillation or similar material) are added, and the mixture is stirred until a dry mass results. This is ground.

MAKING PORTLAND CEMENT.—R. W. Lesley (*Pat. J.*, 1,666, 1920). No. 152,106, July 4, 1919. The hot waste gases from a rotary cement kiln are used to heat retorts containing low-grade carboniferous materials such as oil shale, lignite, etc. The volatile products from the retorts may be passed along a pipe and burned in the kilns or may be used for other purposes, and the ash is added to the calcareous or other ingredients and submitted to the clinkering process, the carbon in the residue forming a part at least of the fuel required in the process. The ash or residue from the retorts is carried by a conveyer to a hopper, to which the cement-making materials are supplied, and the mixture is passed therefrom to the kilns.

MOULDING-MACHINE FOR CONCRETE.—Vickers Ltd. & G. T. Buckham (*Pat. J.*, 1,666, 1920). No. 152,114, July 5, 1919.

ARTIFICIAL MARBLE.—D. Jager (*Pat. J.*, 1,666, 1920). No. 152,359, Oct. 14, 1920. Several separate mixtures of different colours and consistency are made and superimposed in layers, stirred together with or without slaking in such a manner as to avoid complete mixing. A dry mixture of 1 part Portland cement, ½ part silver sand, and ½ part pulverised marble is moistened with water to which is added colouring matter free from H_2SO_4. "Flame markings" are produced by using a larger proportion of water, and the composition for veins with less water. The mass is shaken in moulds without compression, and after drying the face layer is ground off.

IMPERVIOUS PAINT.—C. H. Ivinson (*Pat. J.*, 1,659, 1920). No. 149,365, Nov. 19, 1918. A paint impervious to oils, spirits, petrol, water, etc., and particularly applicable for coating the interior of concrete tanks, consists of 30 to 65 parts zinc chloride, 30 to 55 parts zinc oxide, 2 to 20 parts ammonium chloride, with the addition of water and the ingredients for adding weight hardness, for binding and other purposes. The additional ingredients comprise magnesium chloride, magnesium oxide, silica, borax, powdered glass, an agglutinant such as dextrine, starch, glue, or soluble gum, Portland cement or plaster of Paris. The ingredients may be mixed together and stored in a finely-ground anhydrous condition; or the chlorides may be dissolved separately and the solution used as a vehicle to be mixed with the other powdered ingredients when the composition is required for use.

MOULDING CONCRETE BLOCKS.—J. M. Wellington & D. G. Mackenzie (*Pat. J.*, 1,659, 1920). No. 149,369, Feb. 13, 1919. Description of a machine.

MOULDING CONCRETE BLOCKS.—C. Marques (*Pat. J.*, 1,659, 1920). No. 149,511, July 22, 1919. Description of a moulding machine.

SLAG CEMENTS.—R. Boveroulle (*Pat. J.*, 1,660, 1920). No. 149,988. Aug. 9, 1920. In making cement by the cold process, lime dross, consisting of the residue of the lime which has passed through the grids beneath the kilns together with ashes of the fuel employed, is mixed with granulated slag.

MOULDING CONCRETE.—C. R. Williams (*Pat. J.*, 1,661, 1920). No. 150,190, Oct. 21, 1919. Relates to moulds for ferro-concrete casings for water-closet pans.

MIXING CONCRETE.—H. P. Brown (*Pat. J.*, 1,661, 1920). No. 150,369, Mar. 10, 1919. A method and apparatus for mixing concrete and then granulating the mass by means of a fluid blast and conveying it through a conduit to an improved nozzle through which it is discharged in placing.

MOULDS FOR CONCRETE BLOCKS.—H. A. Hamilton & F. J. Twigg (*Pat. J.*, 1,661,1920). No. 150,462, June 19, 1919.

MOULDING CONCRETE BLOCKS.—A. Young (*Pat. J.*, 1,661, 1920) Nos. 150,565/6, Nov. 19, 1919. Description of machine.

MOULDING CONCRETE BLOCKS.—M. C. A. Brissart (*Pat. J.*, 1,657, 1920). No. 148,356, July 9, 1920. Description of a machine.

MOULDING GYPSUM, CEMENT, ETC.—A Haenicke & C. W. Schulz (*Pat. J.*, 1,658, 1920). No. 148,797, June 10, 1920. Small shaped articles, *e.g.*, buttons, are made from gypsum, cement, etc., by pressing the finely-ground material in a dry state, removing the pressed article from the mould, and subjecting it to a spray of water or other setting-liquid until sufficient liquid has been absorbed. Burnt magnesite may be employed, a lye of chloride of magnesium being employed as a setting-liquid.

MOULDING CONCRETE BLOCKS, ETC.—C. Marques (*Pat. J.*, 1,658, 1920). No. 149,042, May 1, 1919. Description of a machine.

MOULDING CONCRETE BLOCKS.—G. L. Falconar (*Pat. J.*, 1,658, 1920). No. 149,077, May 9, 1919.

MOULDS FOR CONCRETE BLOCKS.—C. Marques (*Pat. J.*, 1,658, 1920). No. 149,154, May 1, 1919. Describes an improved type of mould.

CEMENTS AND MORTARS.—A. Larsen (*Pat. J.*, 1,651, 1920). No. 146,172, June 25, 1920. Mortar or cement is rendered porous by the incorporation of a substance which on the addition of water will cause the evolution of hydrogen or another gas. Suitable additions are aluminium, silicon, metalloids, and the like. Hot water may be used, and if necessary alkalies or soap solution may be added to increase the reaction.

CONCRETE BLOCKS AND SLABS.—W. Wilson (*Pat. J.*, 1,656, 1920). No. 147,983, Apr. 22, 1919. A block or slab is formed in a mould with the face uppermost, and a layer of cement is laid thereon whilst the concrete is still moist. Pebbles or stone chips are then deposited, automatically or otherwise, on the cement, preferably by means of a combined cloth and slide apparatus.

MIXING-APPARATUS.—G. Jaeger (*Pat. J.*, 1,656, 1920). No. 148,076, Sept. 26, 1919. Description of a rotary drum, having a conical upper portion and a lower portion consisting of opposing curved walls and opposing flat walls extending from the bottom.

CONCRETE BEAMS, SLEEPERS, ETC.—O. Smreker (*Pat. J.*, 1,656, 1920). No. 148,135, July 9, 1920. Describes a method of making concrete articles (beams, sleepers, masts, etc.) with inserts of asbestos cement, etc., adapted to receive screws, rivets, etc. Sieves or nettings of fine wire, asbestos fabric, etc., are used, which remain in the article.

VII.—CHEMICAL AND ANALYTICAL PROCESSES.

THE RECOVERY OF SULPHUR FROM GYPSUM.—L. Martin (*Tonind. Ztg.*, **44**, 915, 929, et seq., 1920). An account of various methods adopted in Germany when American and Italian supplies of sulphur were cut off during the war. Raw materials in unlimited quantity were available in

Germany in the form of gypsum ($CaSO_4.2H_2O$ with 18% sulphur), anhydrite ($CaSO_4$ with 23% sulphur) and also heavy spar ($BaSO_4$) and kieserite ($MgSO_4$). Of these, the two latter were not suitable for work on a large scale. After fine grinding, the anhydrite is mixed with about 25% powdered coal and heated in a revolving furnace. At a temperature of about 1000°C. the anhydrite is converted into calcium sulphide according to the formula : $CaSO_4 + 2C = CaS + 2CO_2$. One furnace supplies 80 tons of CaS, with 30 % sulphur, per hour. The material is then cooled, ground, and placed in horizontal iron cylinders, (with a capacity of about 40 cubic metres) containing magnesium chloride solution. Steam is passed into the cylinders, decomposition taking place as follows : $CaS + MgCl_2 + 2H_2O = H_2S + Mg(OH)_2 + CaCl_2$. The H_2S gas is passed by means of an exhauster into 2 telescope gasometers each of 3000 cu. m. contents. From the gasometers, the H_2S is conducted through pipes to the mixing plant, in which 2 parts of air are thoroughly mixed (to avoid explosions) with the 95% H_2S. The decomposition of the H_2S takes place in Claus furnaces, consisting of strong iron cylinders, lined with refractory bricks and measuring about 10 m. in diam. and 5—6 m. high. A layer, 2 m. thick, of bauxite, which at a dull red heat acts as an oxidising agent, covers the grate. The heat from the combustion, which takes place according to the formula : $H_2S + O = H_2O + S$, maintains the bauxite at a red heat. The molten sulphur is run off at the base of the furnace, conducted into cooling basins and finally broken off in blocks of 25 cm. thickness. The product is very pure, containing 99·95% sulphur.

The manufacture of sulphuric acid from gypsum was also greatly developed during the war. At the Fr. Bayer & Co. colour works, a process has been adopted of simultaneously producing H_2SO_4 and cement. Anhydrite is the best raw material, but gypsum may also be used. It is mixed with the necessary quantities of clay, sand and coal and finely ground in special machines. The mixture is fired in a revolving tubular furnace, and the whole of the sulphuric acid is expelled from the gypsum as SO_2. The residue is a cement, which is said to be equivalent to Portland cement, both in composition and properties. The following method is employed at metal works in Duisburg : The anhydrite is broken up into pieces about the size of an egg, and mixed with coarse coke in the proportion of 100 parts anhydrite to 25 coke. The mixture is then passed into rotary grate generators, into which air is introduced under pressure. Combustion can therefore be carefully regulated. The reaction in the furnace is represented by the formula : $CaSO_4 + CO = CaO + CO_2 + SO_2$. Another firm has adopted a similar process, using generator-gas from brown coal instead of coke.

PURE SAND.—(*Tonind. Ztg.*, **44**, 658, 1920). Pufahl recommends the following process for the chemical analysis of sands : After grinding in an iron mortar, the iron abraded from the mortar is carefully removed from the sand with a magnet. The sample is pulverised in an agate (not porcelain) mortar. About 5 grs. of the fine powder is moistened with a few drops of H_2SO_4(1: 1) in a platinum dish, 50 cc. hydrofluoric acid are added and the mixture gently heated in a sand bath, with frequent stirring, until the whole is dissolved. The liquid is then evaporated off, heated until the H_2SO_4 begins to fume, the iron being then extracted from the residue by warming with pure HCl. This solution is then titrated for iron. If the crucible has been previously weighed, the amount of silica can be determined approximately from the loss of weight after evaporating off the H_2SO_4 and strongly heating the residue. Since the latter even then may contain the sulphates of the alkalies ($CaSO_4$, etc.), the SiO_2 content can be determined more accurately by a method which is essentially similar to that outlined in TRANS. **17**, 300, 1918.

A RAPID METHOD OF ANALYSIS FOR PORTLAND CEMENT.—T. Klehe (*Tonind. Ztg.*, **43**, 971, 1919). The writer describes a rapid method of analysis which originated in America. Five grams cement are weighed in a porcelain dish, a little water is added followed by 10 cc. glacial acetic acid. All lumps of cement must be broken up with a glass rod. The dish is then placed on a hot iron plate and the mixture stirred from time to time.

Care must be taken that the liquid does not boil over. Then add dilute HCl to the solution until the red colour disappears. Filter, and wash carefully with hot water. The precipitate is then ignited, cooled, and weighed as SiO_2. The filtrate is diluted to 200 cc. and divided into 2 portions of 100 cc. each. To the first portion add a few drops of HNO_3 and then ammonia, until the sesqui-oxide is precipitated as hydrate. The liquid is then allowed to stand for a few minutes on the warm iron plate to allow the precipitate to settle After filtering, washing and igniting, the ppt. is weighed as $Al_2O_3 + Fe_2O_3$. The separation of the aluminium and iron is then carried out in the second portion, by the Zimmermann-Keinhardt process. The solution is brought to boiling point, stannous chloride is added drop by drop to convert the ferric to ferrous iron. After cooling, the solution is made up to 300 cc. and 25 cc. of manganese sulphate solution are added. It is then stirred thoroughly, and 10 cc. of saturated mercuric chloride solution are added. This is followed immediately by titration with potassium permanganate.

The filtrate from the first portion (precipitation of the sesqui-oxides) serves for the determination of the lime and magnesia. It is made up to about 400 cc., the lime is precipitated as oxalate, filtered, washed, and titrated in the usual way with potassium permanganate. The filtrate, after precipitating the lime, is reduced to about 200 cc. in a porcelain dish, acidified with HCl and transferred to a conical beaker. Sodium ammonium phosphate solution and about 5 cc. ammonia water are then added, the whole shaken vigorously and cooled under the tap. After the precipitate has formed, another 10 cc. ammonia water are added and the solution is again shaken thoroughly for 10 minutes. After allowing 5 minutes for the ppt. to settle, the solution is filtered, washed with ammonia water, ignited, and weighed as magnesium pyro-phosphate.

Meanwhile, the determination of sulphates has been undertaken as follows: 1 gram. cement is mixed with glacial acetic exactly as before, and filtered after adding dilute HCl. The filtrate is boiled, and a few cc. of alcohol are added. The sulphates are then precipitated with barium chloride, and the flask is allowed to stand half an hour on the hot iron. The barium sulphate has by this time settled completely, so that the solution can be filtered rapidly.

The writer is sceptical as regards the reliability of the method, particularly with reference to the determination of magnesia.

TESTING OILS AND LUBRICANTS.—Z. (*Deut. Töp. Zieg. Ztg.*, **50**, 458, 1919). In order to show whether animal and vegetable oils have been diluted with cheaper mineral oils, 30 grs. of the oil as supplied are mixed with an equal quantity of caustic soda solution and heated to 70°C. in a small dish. The saponified mass is then thoroughly dried, and if there is no mineral oil present, none of the dry residue will be dissolved in petroleum ether. After washing with petroleum ether and allowing the latter to volatilize, there should, therefore, be no residue.

THE RE-UTILIZATION OF BUILDING BRICKS.—J. (*Deut. Töp. Zieg. Ztg.*, **50**, 71, 1919). A certain chemico-physical reaction takes place between an unused brick and the mortar, minute particles of the mortar penetrating into the brick and *vice versa*. This tends to produce greater rigidity in the structure. Finally, calcium and aluminium silicates are formed in the texture of the brick. A brick, which has been used once for building purposes, has, therefore, a much denser surface texture where it has been in contact with mortar, than a new brick. It should not be re-used, therefore, in places where great rigidity is required in the structure.

DISPERSOIDS; COLLOID POWDERS.—H. Plauson (*Pat. J.*, 1,676, 1921). No. 156,142, Dec. 31, 1920. Colloid materials are disintegrated between surfaces having very rapid movements (*e.g.*, by means of the apparatus described in Spec. 155,836) in the presence of a large quantity of a non-solvent, which acts as a dispersion medium. The presence of a small quantity of soap, or of a substance in which the colloid dissolves or swells, is desirable in some cases. The products are in sol form, or closely resemble

it, and may be obtained finally as powder or paste, or mixed with fillers and pressed into any shape required.

ALKALI SILICATES.—F. J. Phillips (*Pat. J.*, 1,664, 1920). No. 151,339, June 19, 1919. In order to obtain a soluble alkali silicate of high silica content, the product obtained by the fusion of alkali and silica is dissolved in water and an acid then added, gelatinous silicia acid being thrown down. This precipitate by continued agitation is made to re-dissolve in the solution. The acid, preferable H_2SO_4, may be added in the form of spray, and after the subsequent operation of agitation or grinding, the solution may be evaporated to dryness. To increase the fusibility of the alkali and silica, a little borax may be employed in the fusion process.

DISPERSOIDS.—H. Plauson (*Pat. J.*, 1,676, 1921). No. 155,836, Dec. 24, 1920. Dispersoids or colloidal suspensions of ores, dyes, graphite, cellulose, or other substances, are obtained by pounding or rubbing the ground material in a dispersion medium which is a non-conductor of electricity, the moving surfaces having a velocity of not less than 2000 metres per minute, and preferably of 1000 m. per sec. Dispersion may be assisted by adding solvent chemical agents, or those which form labile compounds with the dispersion medium without much ionization, or those which assist the formation of compounds between the material to be dispersed and the dispersion medium. Different forms of a mill are described with the aid of sketches.

VIII.—HISTORICAL, EDUCATIONAL, INSTITUTIONS, ETC.

THE JAPANESE FINE CERAMIC INDUSTRY.—J. Gr. (*Tonind. Ztg.*, **44**, 1240, 1920).

INSTRUCTION IN CERAMICS AT THE TECHNICAL HIGH SCHOOL, CHARLOTTENBURG.—(*Ber. D.K. Ges.* **1**, No. 1, 38, 1920).

SPA AND THE BRICK INDUSTRY.—Platz. (*Tonind. Ztg.*, **44**, 1043, 1920). Figures are quoted to show that very little best quality coal will be available for the brick industry in Germany after meeting the requirements of the Spa Agreement. Manufacturers are warned to make the necessary arrangements for firing with low-quality brown coal.

CLAY AND KAOLIN WORKS IN SAXONY.—(*Tonind. Ztg.*, **44**, 1062, 1920). Figures taken from official statistics published by the Ministry of Finance. In 1918, there were, in all, 43 working concerns, employing 527 workmen and 44 officials. Among the latter were 32 technical supervisors, or 1 supervisor to every 16 workmen. Attempts to introduce dynamite charging into clay mines were not successful.

PREPARATORY TRAINING FOR THE BRICK-MAKERS' SCHOOL.—(*Tonind. Ztg.*, **44**, 801, 1920). Among the requirements of prospective pupils at the new school at Frankfort-on-Oder, the most important is that they shall have completed two years practical training in a works prior to commencing their studies.

HAMBURG STATE BUILDINGS.—C. Zetzsche (*Tonind. Ztg.*, **44**, 1033, 1061, 1920). An account of the work carried out under the direction of F. Schumacher, since 1909.

DISCOVERY OF A PREHISTORIC SETTLEMENT.—(*Tonind. Ztg.*, **44**, 771, 1920). An ancient settlement, dating back three to four thousand years B.C. has been discovered near Strassfurt, on the western bank of a former arm of the Bode. Very valuable finds have been brought to light.

A CERAMIC HANDBOOK.—(*Tonind. Ztg.*, **44**, 795, 1920). A review of a recently issued Danish publication, under the above title, by Emil Hannover, of Copenhagen, of which the first part, dealing with faience, majolica and stoneware has already appeared. The second part, devoted exclusively to porcelain, is now in preparation.

THE CERAMIC INDUSTRY OF THE CZECHO-SLOVAK REPUBLIC.—(*Tonwar. Ofen. Ztg.*, **43**, 76, 1919).

THE RUSSIAN CERAMIC INDUSTRY.—(*Tonwar. Ofen. Ztg.*, **43**, 88, 1919).

OLD SAXON POTTERY.—(*Tonwar. Ofen. Ztg.*, **43**, 132, 1919).

HISTORICAL NOTES ON THE DEVELOPMENT OF BRICK-MAKERS' SCHOOLS.—(*Tonind. Ztg.*, **44**, 487, 1920).

SOME MODERN ECCLESIASTICAL BRICK STRUCTURES.—(*Tonind. Ztg.*, **44**, 591, 1920).

A THERMO-TECHNICAL ADVICE BUREAU FOR THE GERMAN GLASS INDUSTRY.—(*Sprech.* **53**, 526, 1920).

BAVARIAN BRICK STRUCTURES OF THE ROMANESQUE PERIOD.—Hasak (*Deut. Töp. Zieg. Ztg.*, **50**, 380, 1919).

OLD SAXON ART POTTERY, ETC.—Anon. (*Deut. Töp. Zieg. Ztg.*, **50**, 494, 1919). Deals mainly with the artistic and architectural pottery of the 15th and 16th centuries.

ANCIENT WENDISH POTTERY.—K. Strauss (*Deut. Töp. Zieg. Ztg.*, **50**, 540, 1919). A short discussion. Illustrations are given of some specimens of pottery made by Slavonic tribes east of Berlin, dating back to the VI Century.

THE FIRE-PLACES IN THE OLD CITY-HALL OF LEIPZIG.—(*Tonwar. Ofen. Ztg.*, **43**, 4, 1919).

THE FLOURISHING PERIOD OF SILESIAN FAIENCE.—(*Tonwar. Ofen. Ztg.*, **43**, 4, 1919). The industry reached the height of its prosperity towards the close of the 18th Century.

CERAMIC DISCOVERIES IN THE DOBRUDSHA.—(*Tonwar. Ofen. Ztg.*, **43**, 17, 1919). Two types of pottery were found, the one coarse and natural coloured, the other a finer and decorated variety.

THE FIRST MEETING OF THE GERMAN CERAMIC SOCIETY.—(*Sprech.* **53**, 467, 1920). The first general meeting of this Society was held in Dresden, on September 4th and 5th, and was very well attended. Various technical and scientific papers were read, the text of which will be published in the Society's Reports. A sum of M 100,000 was subscribed to the Society by a number of firms during the meeting.

BRANDENBURG CATHEDRAL.—D. Hasak (*Tonind. Ztg.*, **43**, 1053, 1919). A short historical sketch of "the oldest brick structure in North Germany."

THE OPENING OF THE BRICK-MAKERS SCHOOL AT FRANKFORT-ON-THE-ODER.—(*Tonind. Ztg.*, **43**, 1379, 1919).

LEAD-GLAZE POTTERY IN SILESIA AND SAXONY.—K. Strauss (*Deut. Töp. Zieg. Ztg.*, **50**, 360, 1919). A short account of the districts where lead-glazed pottery was manufactured, mainly in the 18th and 19th centuries.

JEWS' PORCELAIN.—A. Kunth (*Tonind. Ztg.*, **43**, 973, 1919). In order to increase the turnover of his porcelain works, Frederick the Great issued an order in the summer of 1769, to the effect that, on all special occasions, all Jews were to purchase a certain amount of porcelain from the king's works and sell the same abroad. Thus, whenever a marriage was celebrated in the family, or when a new business was opened, or a piece of land purchased, the individual in question had to buy porcelain to the value of 300 crowns.

It was soon found, however, that the order was doing more harm than good, since many of the Jews disposed of their goods abroad at a loss for the sake of the ready money. In the neighbouring countries, the goods came to be known under the name of "Jews' Porcelain." In 1787, the Jews were released from their liabilities on payment of 40,000 crowns.

ROMAN BURNT-BRICK STRUCTURES.—Hasak (*Tonind. Ztg.*, **43**, 1017, 1919). A short historical survey. Vitruvius *De architectura X.* is quoted. The basilica at Trier is illustrated.

THE BELGIAN BUREAU OF CHEMICAL STANDARDS.—(*Bulletin de la Société Chimique de Belgique*, **30**, 42, 1921). The organisation of a Bureau of Chemical Standards was entrusted to Belgium by the International Union of Pure and Applied Chemistry at the annual meeting in Rome in July, 1920. The purpose which the institution is intended to serve will be analogous to that of the Bureau of Standards at Washington, and the Physikalisch-Technisches Reichsanstalt at Charlottenburg. Attention will first be directed mainly to the preparation of pure organic liquids, which are particularly difficult to procure at the present time.

THE JAPANESE CERAMIC INDUSTRY.—Gonnoske Komai (*Times Trade Supplement*, Ap. 16, 1921).

THE HYGIENE OF THE CERAMIC INDUSTRY.—B. Schoeber (*Weyl's Handbuch der Hygiene*, **7**, *Special Part* **5**, 611, 1918). The subject is treated under three main headings—Hygiene of the (I.) brick makers, (II.) pottery workers, and (III.)porcelain industry. In all cases, a short historical sketch of the development of the industry is followed by a well illustrated account of the different manufacturing processes. Statistical details of the number of persons engaged in the industry, together with figures showing the quantity and value of the imports and exports to and from Germany from 1909 to 1913, are included in a third subdivision.

Occupational diseases and general hygienic conditions in the brick industry. From 20 to 25% of sickness among brick workers is due to rheumatism, nasal catarrh, tonsilitis, etc., owing to the conditions under which they work, exposure to wind and weather, the heavy nature of their duties, etc. Diseases due to dust are less common in general; they are usually contracted by men engaged in charging and discharging the kiln chambers. On many large works, exhausters have been fitted up, to draw off the hot air and introduce fresh cold air into the chambers. By this means, the general health and working capacity of the men is considerably improved. After the workman has inhaled a hot, dusty atmosphere for several hours, the delicate tissues of the upper respiratory organs become inflamed, so that, in time, a lowering of his capacity to resist the attack of infectious diseases—particularly of tuberculosis—tends to take place. According to Leymann, tuberculosis has hitherto not been found to be prevalent among brick workers.

Rühle describes a form of anæmia, which usually attacks young, robust men; its main symptoms are a yellowish complexion coupled with great lassitude. The white blood corpuscles are normal, the red reduced in number and size, spherical in shape, and pale in colour. The complaint yields but slowly to iron treatment. In a number of cases this form of anæmia was shown to be due to the presence of ankylostoma germs. The provision of a plentiful supply of pure drinking water and ample lavatory conveniences is a most necessary precautionary measure against ankylostomiasis, a disease which apparently has its origin in impure water. As in most branches of industry, housing conditions and the general standard of living among the workers are important considerations from the hygienic point of view.

Occupational diseases among potters. Where the clay is still pugged by hand, distension of the lungs (emphysema) has repeatedly been diagnosed; this is due to the heavy nature of the work which requires abnormal breathing and simultaneous pressing. The complaint almost invariably leads to heart trouble. Work at the potter's wheel involves a continuous stooping and bending forward, so that the chest tends to become cramped. In time, this

leads to disturbances in the blood circulation and in the digestive organs, unless the workman has the opportunity of changing his work occasionally for some other duties, such as placing or sorting. For various reasons, the atmosphere in the shops becomes warm and moist, so that the men are very liable to contract chills. Repeated chills lead to rheumatism, gout, and catarrh with all the dreaded complications such as pneumonia, pleurisy, etc. Cases of phthisis are nevertheless comparatively rare; the percentage of consumptives is no higher than in other branches of industry. It is generally assumed that consumption is very prevalent among pottery workers, but the writer was unable to procure reliable statistics supporting this view. In cases where a few figures are given, they refer to periods when really reliable bacteriological tests were not applied, and merely general, subjective symptoms were taken as indicating galopping, wasting or hectic consumption, so that these figures can no longer be accepted. During nine years experience as a medical practitioner in the Bunzlau district, where pottery workers are comparatively numerous, the writer found no indication of the undue prevalence of phthisis; on the contrary, tuberculosis could not be considered an occupational disease of the potters in that locality. An explanation of the remarkably low percentage of consumptives among potters may perhaps be found in the properties of the clay itself. The cleansing properties (oil and grease absorbing) of finely divided clay are well known. It is possible, therefore, that when bacilli fall on particles of clay dust the albumen of the organisms is affected by the clay, and in addition, their virulence is weakened by a more rapid absorption of moisture. *Lead poisoning* is the chief occupational disease of potters. In the Prussian hospitals 9 cases of this complaint were treated in 1904, 16 in 1905, 27 in 1906, 26 in 1907 and 18 in 1908. Gas or dust masks should always be worn as a precautionary measure against lead poisoning. At the Wächtersbach Earthenware Works, all workers in lead glazes are allowed longer meal hours, which must be spent in the mess-rooms. In addition, the following regulations are prescribed: (1) The shops must be kept clean; in particular, the floors must be washed clean of all glaze dust, etc., every day. The rooms must be thoroughly ventilated once a day. (2) Special overalls and caps must be worn during working hours. Smoking and chewing tobacco is strictly forbidden. (3) No food or drink must be kept or consumed in the shops. (4) Meals must be taken in the mess-rooms. Before meals, overalls and caps must be discarded, the mouth rinsed out with clean water, the hands and face washed thoroughly with soap and hot water. The same precautions must also be taken by the workpeople before leaving the works at night. Soap, warm water and clean towels should always be available to the workers, and free bathing facilities should be provided.

Occupational Diseases among Porcelain Workers. The dust created in the preparation of raw materials, bodies, etc., is again the chief cause of the occupational diseases among these workers, the conditions being similar in many ways to those dealt with in the previous section. In saggar-making, the heavy nature of the work leads to anhelation and chronic pulmonary trouble. According to Lehmann, who examined carefully the figures of the Porcelain Workers' Union for 1907-1913, when the total membership reached at least 66,700, the mortality reached 0·903%, and of this, 0·34% was due to tuberculosis. These figures compare very favourably with those for the whole of the male population of Bavaria of the same age. As in other branches of the industry, the hygienic measures to be aimed at are the prevention of dust in every possible way, the encouragement of thorough cleanliness both in the shop and in the home, the substitution of mechanical power for the heavy manual labour, etc. The employees should also be encouraged to indulge in outdoor exercise to the fullest extent. The expectorations of each workman and his family should be examined microscopically from time to time by the works doctor, and all cases of infection reported for sanatorium treatment. Numerous bibliographical references (German and Austrian) are appended.

INDEX OF ABSTRACTS.

A

Abrasive and Refractory Compositions. E. Assie, 10
— : Fused alumina for — purposes. Carborundum Co., 63
Acid-proof Stoneware. E. Wilde, 9
— — Vessels. W. E. Richards, 60
Acids : Effect of — on Concrete, 117
Acid-pots. H. T. Arrowsmith, 63
Adair, J.—Drying China Clay, 3
Air and Draught Regulating of Furnaces. G. H. Gibson, 11
— Cracks in Grog Products. Fischer, 98
— Separator : Efficient —, 22
— Separators, 22
— slaking of Magnesia calcined at various temperatures. A. M. Sen, 54
Aktiebol. Gustafsberg-Fabriks-Inter.—Jollies, 92
Aktiebolaget Lean.—Moulding Cement Blocks, 122
Alexander, T. R.—Furnace Feeder, 70
Alkali Silicates. F. J. Phillips, 127
Allbright, D., see J. E. Sproat, 14
Allen, B. J. Casting Pottery, 21
— E. & Co., see W. J. Coles, 21
Allsop, T., and W. W. Sibson.—Drying Machine, 64
Alumina. K. J. P. Orton and G. W. Robinson, 2
— : Fused — for abrasive purposes. Carborundum Co., 63
Aluminates. Rochette Frères, 1
Aluminium Nitride. V. Gerber, 2
American Coke and Chemical Co., and A. Roberts.—Coke Ovens, 13
Ammonium Sulphate from Rock Gypsum, 51
Analyses : Kaolin for Tannin — K. W. Frey, 56
Analysis of Silicate and Carbonate Rocks. W. F. Hillebrand, 42
— : Rapid Method of — for Portland Cement. T. Klehe, 125
Anderson, D. W. and A. D. Dabney.—Furnaces, 12
— R. J.—Powdered Liquid or Gaseous Fuel Furnaces, 72
"Angle" bricks. Schoenfelder, 60
Anklam, G.—Filter Sand, 1
Annealing Furnaces. H. M. Thompson, 36
Annular Kiln Fireman. M. Grimm, 82
— Kilns : Coal-saving of Firing — — P. Thor, 82
— — : Firing Pottery Utensils in — — T. Klein, 83
— — : Fuel Consumption in — — K. Dümmler, 83
— — : Repair work in the Combustion Chamber of — — 84
Antoine, V.—Disk-mills, 92
Apparatus for Conveying and Screening. R. A. Hadfield, 93
Armour Fertilizer Works.—Electrode Furnaces, 15
Arrowsmith, H. T.—Acid-pots, 63
Art-Pottery : Old Silesian — — K. Strauss, 44
Artificial Marble. K. Haerting, 118
— — P. J. Guillot, 120
— Stone. J. Ward, 121
— — P. B. Crossley, 114
— — Slabs for Railway Crossings, 39
— — White Heat Products Co., 9
— Teeth : Porcelain for — — 9
Asbestos-cement Slabs. W. Schmidt, 39
Ashes : Utilisation of — from Porcelain and Earthenware Kilns. M. Sauer, 64
Assie, E.—Electrode Furnaces, 15
— — Refractory and Abrasive Compositions, 10
Atterburg, G.—Gypsum as substitute for Putty, 117
Atkins, H.—Brick Manufacture, 106
Atkinson, J. S., Stein and Atkinson and T. C. Moorshead.—Glass Furnaces, 36
— see D. M. Cunningham, 17
August, J. R. C.—Electric Furnaces, 73
— — — — Furnaces for Metal-heating, Glass, Pottery, 17
— — — — Rotating Muffle Furnaces, 74
Automatic Bottle-blowing Machine. A. Ferguson, 114
— — — G. O. Tague, 113
— Brick-cutters. K. Dümmler, 90
— Carriers, 105
Avery, T. & W. and H. N. Cox.—Hardness testing Machines, 24

B

Badder, H. C.—Roofing Tiles, 96
Badermann, G.—Ceramic Art in Syria and Mesopotamia, 44

Baggley, C.—Jolleying, 92
Bailey, J.—see Corning Glass Works, 36
Bakema, F. W.—Discharging Shaft Furnaces, 75
Balaji Rao, B.—Prospecting for Kaolin in the Koppa Taluk, 50
Baldermann, C.—Circular Flattening Ovens and Lehrs for Plate Glass Bottles, etc., 108
— — Copper-ruby Glass for Casing, 108
— — Dimensions of Glass Pots, 35
— — Glass-blowing, 33
— — Grog Bricks, etc., for Building Glass Ovens and Tanks, 58
— — Melting Process in Low Glass Pots, 33
Ball and like Mills. J. E. Kennedy, 91
— Mills. H. W. Hardinage, 91
— — J. R. Broadley, 91
Balley, K. M.—Ceramic Firing Process, 65
Balltern, G.—Forgotten Fluxes, 9
Bartram, C. G.—Concrete Pipes, Tunnels, 122
Bas, W. J. de.—Concrete, 120
Baschant.—Labour-Saving devices in Brick-Making Industry, 83
— Manufacture of Gypsum Moulds for Interlacing Tiles, 60
— Possible Utilisation of various Fuels, 83
Batches for Laboratory Glass, 34
Bauxite: Hungarian — 2
Bavarian Trass. Gebauer, 4
— — W. Sieber, 48
Baylor, H. D.—Cement, 122
— — — Slow-setting Cement, 123
Beads: Moulding Glass — W. Haunich, 33
Beard, G. F. H.—see R. and J. Dempster, 15
Beatty, J. M.—see O. M. Tucker, 112
Behrens, A.—Brick Manufacture near Petrograd, 31
Belgian Bureau of Chemical Standards, 129
Bells United Abestos Co., J. A. Cann and E. Hurden.—Building Blocks 121
Bencke, A.—Colloidal Character of Clay from the practical Point of view, 55
Bending Strain of face and Sand-lime Bricks, 97
Benjamin, G. H.—Tunnel Kilns, 67
Bennett, M. H.—see Scovill Manufacturing Co., 15
Bentall, E. E. and G. C. Bingham.—Sifter for Grinding-Mills, 93
Berg, M. J.—Distilling; Coking, 12
— R.—Prevention of Devitrification of Glazes, 19
Bergau, G.—Manufacture of Refractory Materials in Turkey during the War, 44
Berge, A.—Introduction to Ceramics, 44
Berger, T.—Bottle Machine Moulds, 109
— — — Machines, 109
— — — Making Machine, 109
Bernhard, K.—Peculiar Phenomenon, 44
"Berra," new hollow flooring Bricks. F. Rücker, 60
Bied, J.—Refractory Products Industry, 55
Bigot, A.—Calcining Furnace, 75
— — Silica Products, 55
— — Tunnel Kilns, 73
Bingham, G. C.—see E. E. Bentall, 93
Blast Apparatus for Furnaces. H. Stansfield, 68
— Furnace Cement Goods. H. Passow, 118
— — Hearth. W. Mathesius, 83
— Heater for Gas Generators. Eisenwerks Jagstfeld Ges., 66
Blasts: Steam-jet or Under-grate — 76
— — — *v.* Under-grate Fans. L. Friedlander, 18
— — — or Under-grate Fans. O. Schott, 18
Blocks: Moulding Cement — Aktiebolaget Lean, 122
— — Concrete — 123
— — Hollow — G. Kulhn, 121
— — Hollow Concrete — E. Keel, 122
— — Machine for Concrete — 122
Blondel, E.—Resistant and non-actinic Paint for Cement, 119
Blow Iron: Removing Articles from —. R. Haddon, 113
— Irons: Receptacles for — —. A. J. H. Haddan, 111
Blower: New Undergrate — 88
Blowers: Undergrate — L. Friedlander, 66
— — L. Schmitt, 66
Blowing: Glass — forming Electric Lamp Bulbs. E. Lecoultre, 37
Bodies: Fancy-ware — and Glazes, 9
— for Porcelain Buttons, 9
Böndel, O.—Grading of Refractory Bricks, 96
Boehring, F.—Chamotte Mortars, 41
Bog Iron-ore, 51
Boilers: Liquid Fuel for Steam —. Ingold, 81
Boillot, M. L. and J. Dandignac.—Electrode Furnaces, 15
Bond Clay: Refractory — —. Seger and Cramer, 6
Book-keeping: Brickworks —, 105
— : More —. W. B. S., 103
Book-shop: Value of Works — —. C. Sieg, 31
Booth Electric Furnace Co. and J. R. Hall.—Electrode Furnaces, 12

Bosher, C. W.—Moulding Bricks, 60
Bosz, B.—Plaster floors for Granaries, 42
Bottle-blowing Machine. Boucher et Fils, 109
— — —. W. J. Miller, 114
— — —. Wilzin Autom. Bottle-Blowing Mach. Co., 103
— — —: Automatic — — — A. Ferguson, 114
— — —. G. O. Tague, 113
— — —. S. E. Winder, 114
— Industry: Labour Economy and Increase in Output, 35
— Making Machine. T. Berger, 109
— — —. Wilzin Automatic Bottle-Making Machine Co., 112
— Machine Moulds. T. Berger, 109
— Machines. T. Berger, 109
Boucher et Fils,—Bottle-blowing Machine, 109
— C. et Fils. — Glass Furnaces, 37
Boudouard, O.—Porcelain Insulators, 100
Boulton, Ltd., W.—see E. Johnson, 92
Boveroulle, R.—Slag Cement, 123
Braesco, P.—Study of Transition Points by a Dilatometric Method, 52
Brand, J. J. C.—Powdered-fuel Furnace Feeder, 66
Brandenburg Cathedral. D. Husak, 128
Brandt, O.—Manufacture of wood Briquettes, 65
Braven, G. A.—Concrete for building Blocks, 121
Brearley, H.—see L. Johnson, 24
Breyer, F. G.—see New Jersey Zinc Co., 13
Brick: "Berra" new-hollow Flooring — F. Rücker, 60
— Bodies: Hot method of preparing Sand-lime — — (Schwarz Machine) H. Jolig, 93
— Conveyors, 93
— Cutters: Automatic — — K. Dümmler, 90
— Cutting Machine. W. Smith, 91
— Driers: Tunnel — — T. Entwistle, 64
— Hollow — Question. A. Hielscher, 58
— Industry and the Taylor-System. Grüneisen, 31
— — Eight hour day in the — — W. Matthies, 105
— — Lime and Sand-lime — — B. Krieger, 102
— — Manufacturing Costs in — — G. Hüther, 31
— — Reorganization of — — J. F. Kleine, 31
— — Spa and — —. Platz, 127
— — Wages Question in — — A. Milde, 102
Brick Kilns. A. Sharratt, 14
— — A. W. F. Weigers, 68
— — T. West, 72
— Machines. A. Huart, 21
— — W. J. Todd, 90
— Makers' School at Frankfort-on-the-Oder, 128
— — — Historical Notes on the development of — — — 128
— — — Preparatory Training for the — — 127
— making Industry: Possible Utilization of various Fuels in — —. Baschant, 83
— — — Labour-Saving devices in — — —. Baschant, 83
— — Machines. P. Piesnack, 90
— — Practice: Improvements in — A. Bührer, 58
— Manufacture. H. Atkins, 106
— — near Petrograd, A. Behrens, 31
— : Mechanical Efficiencies of — Presses. C. A. Kierling, 22
— : Neuss Sand-lime — Works. B. Krieger, 58
— Presses. Établissements Rouchard et Lamassiaude, 21
— Production: Coal Saving — — G. Hreyer, 8
— Works: Steam-meters for Sand-lime — — 93
— Shapes: New — — and building Processes. Schoenfelder, 8
— Structures: Modern Ecclesiastical — — 128
— —: Bavarian — — of the Romanesque Period. Hasak, 128
— Transport: Taylor System applied to — — 104
Bricks. C. C. Millard, R. A. Robertson and C. J. Cooper, 10
— : Action of Ferric Oxide on Silica — 28
— : "Angle" — Schoenfelder, 60
— : Bending Strain of Face and Sand-lime — 97
— Blocks, etc., Moulding — — G. C. Thomas, 92
— : Cause of Cracking and Scaling of Glazed — W. Pukall, 88
— : Concrete Blocks as Substitutes for—. E. Tucker, 39
— : Concrete "Box" —, 118
— : Cost Estimation of Sand-lime —, 105
— : Crushing Strength of full and perforated — Hielscher, 98
— : Eccentric Presses for grog — 60
— : Fire — T. W. Keillar, 96
— : Grinding of Refractory — O. Böndel, 96
— : Grog — for building Glass Ovens and Tanks. — J. Baldermann, 58

Bricks: Hollow — L. Schmelzer, 8
— : Hollow Block — F. Erdmenger, 40
— : Impervious Sand-lime — L. Gerber, 28
— : Light Plaster — Grossheim, 58
— : Malinite Process for making Refractory Sillimanite — H. Sachse, 58
— : Manufacturing cost of — 102
— : Manufacturing costs for full and hollow — 105
— : Moulding — C. W. Bosher, 60
— : Porosity and Volume changes of Clay Fire — at Furnace Temperatures. G. A. Loomis, 24
— : Refractory — under Load; Behaviour at High Temperatures. K. Endell, 98
— — War Experience in the German Navy. Schulz, 96
— : Re-Utilization of Building — 126
— : Roller Track-Conveyor for — 94
— : Rough End Face — *v.* Plastering for Building Purposes. G. Hanel, 40
— : Sand for Sand-lime — B. Krieger, 1
— : Sand-lime — 40
— — — for Paving. H. Jolig, 95
— : Silica — in Coke-Oven Construction. J. Enzenauer, 84
— : Suitable Fire — M. Kämpffer, 28
— : Testing Swedish — Son Schlyter, 42
— : Unburned — Hirsch, 7
Bricklaying: Taylor System applied to — C. Sickel, 31
Brickwork: Effect of Electric Current on — 97
Brickworks: Book-Keeping on — 105
— : Establishing the output of — K. Wendler, 32
British Thomson-Houston Co. — Coating Glass Surfaces, 111
— — — Finishing Lamp Bulbs, 111
— — — Refractory Substances, 61
— — — and H. Hastings.—Electrode Furnace, 67
Broadley, J. R.—Ball-mills, 91, 92
Brown, H. P.—Concrete Mixing, 121, 124
— Coal: German versus Bohemian — — H. Ernst, 75
Brissart, M. C. A.—Moulding Concrete Block, 124
Briquettes: Manufacture of wood — O. Brandt, 65
— : Reconstruction of Grates for Firing with — O. Schöne, 65
Bubbles in Glass, 32
— : Removing — from Molten Glass. Schott and Gen., 112
Bucket Conveyors. Randolf, 22
Buckham, G. T.—see Vickers Ltd., 123
Buckley, E. J.—Modelling Compositions, 10
Bühner, A.—Improvement in Brick making Practice, 58
Building Blocks. C. P. Lovell, 60
— — Bells United Asbestos Co., J. A Cann and E. Hurden, 121
— — : Moulding — — C. H. Schol, 6
— — : Moulding — — J. Stephenson, 9
— — : Moulding — — K. Hessel, 12
— Bricks: Re-Utilization of — — 12
— Industry: Standardisation in the — — K. Matthies, 31
— Material: Rough and Face Bricks Plastering. G. Hanel, 40
— Materials: Economic — — Neumann 39
— — :Slag attack on Refractory — — 3
— Methods: Economic — — 8
Buildings: Hamberg State — C. Zetzsch 127
— of note in East and West Prussia. C Sichel, 44
Bultemann, E. F. A.—Electric Insulation Plastic Compositions, 10
Bulbs: Forming Electric Lamp — E Lecoultre, 37
— : Finishing Lamp —. Br. Thomson Houston Co., 111.
Bunce, E. H.—see New Jersey Zinc Co., 1
Burned Lime: Buy — — according to it Calcium Oxide Content. H. Echert,
Burning lime with Coal with high sulphu content. E. Donath, 65
— of Magnesite in Electrically Heate Kilns. Cost of — W. F. Smeeth, 5
Burnt-Brick Structures: Roman — — Hasak, 129
Buttons: Bodies for Porcelain — 9

C

Calcining Furnace. A. Bigot, 75
— — A. V. Gower-Lecesne, 73
Calcium Oxide: Buy Burned lime accord ing to its — — Content. H. Echert 2
Calculating Ceramic Recipes: Diagram matic Method of — — A. Pfoff an M. Donath, 61
Calculations of Hardness or Expansion o Glass. L. Springer, 34
Campbell, D. F.—Electric Furnaces, 6
— — — Gifford, W. S. and Waite, H. S Electrode Furnace, 67
Candlot, C.—Lime Kilns, 73
Cann, J. A. and E. Hurden—Building Blocks, 121
— — — see Bells United Asbestos Co., 12
Carbide Lime as a building Material, 52
Carbonate and Silicate Rocks: Analysi of — — W. F. Hillebrand, 42

Carbonizing Apparatus. H. A. Fawcett, 16
Carborundun Co.—Fused Alumina for Abrasive Purposes, 63
Carboys, etc. H. Wade, 114
— : Making — H. Wade, 111
Carrier : Chainless — 93
Carriers for Tunnel Kilns. R. C. Metcalfe, 75
Casting Concrete. J. H. Harrison, 120
— : — Faulty — of Porcelain. O. Rose, 11
— Heavy Porcelain Appliances for Electrical Purposes, 60
— Pottery. B. J. Allen, 21
— Pots for Optical Glass. A. B. Taylor, 37
— Slag. T. F. Hoare, 11
Cement. H. D. Baylor, 122
— : Asbestos — Slabs. W. Schmidt, 39
— : Behaviour of Ultramarine in — K. Haerting, 118
— Black, 42
— : Blast Furnace — Goods. H. Passow 118
— Blocks : Moulding — — Aktiebolaget Lean, 122
— : Determination of Dust in Flue Gases of Annular Kilns for Burning Portland — O. Schott, 18
— Factory : Works Management in a — — O. Schott, 103
— : Fibro — Products. R. V. Mattison, 7
— Flushing Cisterns, 40
— goods : Compressed Air for — — 40
— : Good Portland — K. Reinbold, 41
— — : Ramming Machine for — — 24
— : Gripping power of — H. Luftschitz, 41
— in Water containing Sulphuric Acid. W. Roeder, 41
— : Making Portland — R. W. Lesley, 123
— : Manufacture of Hydraulic Lime and Natural — G. Lefevre, 119
— : Mixing — Powder with Coke Slack. H. Roder, 40
— Palisades, 118
— Pipes : Centrifugal Machine for — — 119
— — : Impermeable — — 117
— — : Moulding — — A. O. Crozier, 122
— : Porcelain — Porzellanfabrik Kabla, 62
— : Rapid Method of Analysis of Portland — T. Klehe, 125
— Refuse Bins, 118
— Rollers and Field work, 40
— Roofing Tiles. Kroher, 39
— — — 118
— — — : Manufacture of — — — 40
— : Resistant [illegible] actinic Paint for — E. Blondel, 119
— Saver : Trass as a — — H. Sachse, 117
Cement : Simple Apparatus for Testing — R. Grün, 118
— : Slag — R. Boveroulle, 123
— : Slow-setting — H. D. Baylor, 123
— : Substitute for — C. Platzmann, 120
— Tiles : Danish Machine for making — — 39
— — Waterproof — — 39
— : Trass and Portland — G. Fredl, 116
Cements and Mortars. A. Larsen, 124
Cemetries, Tombstones, etc., Ceramics for — — J. Lerg, 44
Centrifugal Force : Moulding by — — Vickers, Ltd., and N. E. Dufty, 21
— Machine for Cement Pipes, 119
Ceramic and Glass Industry : Situation in the Swiss — — — 103
— — Paper Kaolin, 48
— Art in Syria and Mesopotamia. G. Badermann, 44
— Chromatology. W. Ostwald, 89
— Discoveries in the Dobrudsha, 128
— Firing Process. K. M. Balley, 65
— : German — Society, 44
— Handbook, 128
— Industry : Eight-hour day in the — — F. Sperber, 105
— — Hygiene of the — — B. Schoeber, 129
— — in Germany, Substitutes for Foreign Raw Materials. J. Klug, 1
— — of Japan. Gonnoske Komai, 129
— — of the Czecho-Slovak Republic, 128
— — : Proper Appreciation and Remuneration of Scientific Work in the — —. Koeiner, 103
— — : Russian — — 128
— — : Situation in German — 103
— : Japanese Fine — Industry, 127
— Raw Material in France, 47
— Recipes : Diagrammatic Method of Calculating — — A. Pfoff and M. Donath, 61
— Society : First Meeting of the German — — 128
— Works : Mechanical Appliances in Fine — — A. Sauer, 90
Ceramics : Experiences in — E. Heinecke, 44
— for Cemetries, Tombstones, etc. J. Lerg, 44
— : Instructions in — at Technical High School, Charlottenburg, 127
— : Introduction to — A. Berge, 44
Chainless Carrier, 93
Chamberlin, B. D.—see Empire Machine Co., 37
Chamotte Mortars. F Boehring, 41
Chantraine, A. B.—Furnace Regenerators, 68

Charging Kilns. G. A. Collins, 33
— of Furnaces. F. Clements, 69
Chemical Construction Co.—Potassium Salts, 1
— Industry: Refractory Materials used in — — R. Kien, 47
— Standards: Belgian Bureau of — — 129
Chemistry: Colloidal — 43
Chimneys: Dissipator — 76
China and Earthenware: Firing of — — H. J. Johnson, 72
— Clay drying. J. Adair, 20
Christopher, J. E.—Coking, etc., 14
Chromatology: Ceramic — W. Ostwald, 89
Chrome-green Glaze: Effect of Zinc on — — — 19
Cirkel, C.—Trade Combines, 102
Cisterns: Cement Flushing — 40
Clauss, R.—Engineers for Firing Technique in the Ceramic Industry, 75
— — Thermal "Balance-Sheet" of an Annular Kiln, 66
Clay and Kaolin Works in Saxony, 44, 127
— — Marl Excavators. J. Strehl, 102
— as a Remedy. H. Jacer, 45
—: British Fire — suitable for Glass Furnace Refractory Materials. E. M. Firth, F. W. Hodkin and W. E. S. Turner, 3
—: Colloidal Character of — from Practical Point of View. A. Bencke, 55
— containing Lime, used for Tiles. H. Jordt, 9
— Cooking Utensils. K. Ernst, 8
— Deposits: Valuation of — — 103
—: Drying China — J. Adair, 3
—: Excavating — Weber and Co., 51
— Fire Bricks: Porosity and Volume Changes of — — at Furnace Temperatures, 24
— Occurrences: Kaolin and — — in the Koppa Taluk. P. S. Iyengar, 50
— or Stoneware Utensils for Poultry Farms. A. Wulf, 60
—: "Osmo" — 48
—: Preparation of Saggar — 9
—: Prospecting for — L. Schmelzer, 1
—: Refractory Bond — Seger and Cramer, 6
—: Treating — P. Schidrowitz, W. Feldenheimer and W. Plowman, 51
Clays and Shales of Minnesota, F. F. Grout, 1
—: Fired colour of Lime-containing — Loeser, 83
— for Tiles, 48
—: Treating — W. Smith, 60
—: Does it Pay to Improve —? R. Seydel, 30
Clays: Effect of Firing Period on the Vitrification of — H. Sachse, 66
—: Possibilities of Pottery Manufacture from Iowa — W. G. Whitford and O. J. Whittemore, 4
Clements, H.—Liquid Fuel Burner, 67
— F.—Furnace Charging, 69
Coal and Concrete. W. Petry, 40
—: Burning Lime with — with High Sulphur Content. E. Donath, 65
—: Firing with brown — 65
—: German versus Bohemian Brown — H. Ernst, 75
—: On Saving — W. Engelhardt, 76
—: Peat as Substitute for — 84
— Saving Brick Production. G. Heyer,
— — method of Firing Annular Kilns P. Thor, 82
—: Tar-oil instead of — A. Schmid, 18
—: Unburned — below the Fires, 18
— dust: Firing with — — C. Degelow, 8
Coating: Refractory and Protective — o Furnace Linings. E. R. Stowell, 81
Coatings: Fire-proof — of Plaster of Paris 39
—: Metal — H. Welte, 7
Coffee-pots, etc. W. H. Mitchell, 63
Coins: Porcelain — made at Meissen, 8
Coke for Hoffmann Kilns. Loeser, 17
— Oven Construction: Silica Bricks in — — J. Enzenauer, 84
— Ovens. American Coke and Chemical Co. and A Roberts, 13
— — etc. W. E. Davies, 11
— — Fours & Procédés Mathy. Soc. Anon. 12
Coking; Distilling. M. J. Berger, 12
— etc. J. E. Christopher, 14
—: Low Temperature — J. Swinburne, 1
Coles, W. J. and E. Allen & Co.—Mixing 21
Collins, G. A.—Changing Kilns, 73
Colloid Powders; Dispersoids. H. Plauson, 126
Colloidal Character of Clay from the Practical Point of View. A. Bencke 55
— Chemistry and a "Colloid Mill", 43
Colorimetric Tests for Minerals and Rocks with Organic and Inorganic Colouring Media. W. Zwieg, 42
Colour: Fired — of lime-containing Clays Loeser, 83
—: Prime — Ceramic Photography. C. Hisk, 20
Coloured Glass. K. Warga. 112
Colouring Doll Heads, 90
Colours: Effect of Kiln Gases on Terra-cotta — F. B. Ortman, 14
—: Glost-oven Porcelain — W. Funk, 90

Combines : Trade — C. Cirkel, 102
Combustion Chamber : Repair Work in the — — of Annular Kilns, 84
Commission on Smoke and Dust Question, 84
Compositions : Modelling — E. J. Buckley, 10
Composition of Fireclays suitable for Glass Furnace Refractory Materials. E. M. Firth, F. W. Hodkin, and W. E. S. Turner, 3
Compressed Air for Cement Goods, 40
Concrete. W. J. de Bas, 120
— and Coal. W. Petry, 40
— — Mortars. E. Link, 120
— — — Spraying Process for — — 40
— Beans, Sleepers, etc. O. Smreker, 124
— Blocks and Slabs. W. Wilson, 124
— — as Substitutes for Bricks. E. Tucker, 39
— — : Moulding — — A. Young, 124
— — : — — — C. Marques, 123, 124
— — : — — — E. Lechat, 121
— — : — — — G. L. Falconar, 124
— — : — — — J. M. Wellington and D. G. Mackenzie, 123
— — : — — — M. C. A. Brissart, 124
— — : — Machine for — — N. A. M. Mc Dowell, 122
— — : Moulds for — — H. A. Hamilton and F. J. Twigg, 124
— — : Size of Hollow — — 40
— "Box" Bricks, 118
— : Casting — J. H. Harrison, 120
— Chimney Flues. E. W. Thomeley, 121
— : Effect of Acids on — 117
— : — — Fuel Oils on — A. Guttmann, 116
— : Ferro — instead of Granite. T. Conring, 41
— : — — "Mats" for Canal Construction, 119
— : — — Shipbuilding, 39
— : — — — 120
— : Fire-resisting Property of Limestone, 39
— : — Tests on Reinforced — 41
— for building Blocks. G. A. Braven, 121
— : "Gripping" Property of — on Iron, 117
— Kerb-stones, 39
— : Level Crossing covered with — 40
— Mixing. H. P. Brown, 121, 124
— Kerbstones, 39
— : Level crossing covered with — 40
— Mixing. H. P. Brown, 121, 124
— Moulding. C. R. Williams, 123
— : — — T. J. McDowell, 120
— : — — Blocks. E. L. Warren and W. J. Parker, 122
Concrete : Hollow — Blocks. E. Keel, 122
— : — Machine for — Vickers Ltd., and G. T. Buckham, 123
— Park Benches, 39
— Pipes. J. A. Glendinning, 121
— — Tunnels : Reinforced — — G. C. Bartram, 122
— : Proofing — J. Marcusson, 120
— : Reinforced — E. Maier, 122
— Rings for Wells. R. Fabian, 42
— : Rusting of Iron in Ferro — H. Luftschitz, 40
— Staircase : Reinforced — — Gaehme, 118
— Shipbuilding : Ferro — — 119
— Ships : Re-inforced — — 40
— Stonework : Standardisation of — — for Balustrades. A. Friesecke, 38
— Tank for Ammonia Water. Grossheim, 117
— Walls. K. Yamaguchi, 121
— : Waterproofing — K. Winkler, 122
— When is it dry ? R. Fabian, 42
Concretes and Mortars. F. L. Smidth & Co., 38
Conring, T.—Ferro-concrete instead of Granite, 41
Continuous Kiln. See Kilns
Control : Government — P. Ermisch, 105
— of Kiln, 83
Conveying and Screening Apparatus. R. A. Hadfield, 93
Conveyor. J. West, 93
— for Bricks, 93
— : Roller track — for Bricks. 94
Conveyors : Bucket — Randolf, 22
— or Automatic Carriers : Endless — — 105
— : Steel Belt — 94
Cooking Utensils. E. Tuschhoff, 59
— — : Clay — — K. Ernst, 8
Cooper, C. J.—see C. C. Millard, 10
Copper-ruby Glass for Casing, 108
Corning Glassworks and J. Bailey. Glass Furnaces, 36
— — — Glass for Electric Lamp Bulbs, 109
Corthesy, J. H.—Gas-generators, 68
Cost Estimation of Sand-lime Bricks, 105
— : Manufacturing — for Full and Hollow Bricks, 105
— : Manufacturing — of Bricks, 102
Cox, H. N.—see W. & T. Avery, 24
Cracks : Air — in Grog Products, 98
Cracking and Scaling of Glazed Bricks. W. Pukall, 88
Cramer—see Seger, 6
Cramm, H.—Pulverising Mill, 93
Crozier, A. O.—Moulding Cement Pipes, 122

Crucible Furnace. A. E. White, 68
Crucibles: Refractory — 61
Crusher: Gyratory — Smith Eng. Works, 91
Crushing Strength of Full and Perforated Bricks. Hillscher, 98
Cryolite on Glass Pots: Effect of — — — 35
Cucurny y Sanmarti, L.—Moulding Hollow-ware, 64
Cumpsty, J. H.—Furnace Structures, 75
Cunningham, D. M. and Stein and Atkinson. Tunnel Furnaces, 17
Cupola Furnaces: Refractory Lining for — — H. Geyer, 82
Czecho-Slovak Republic: Ceramic Industry of the — — — 128

D

Dabney, A. D.—see D. W. Anderson, 12
Dandignac, J.—see M. L. Boillot, 15
Danish Machine for making Cement Tiles, 39
Danner, E.—Glass Manufacture, 113
— — see Libbey Glass Co., 36
Daubenspeck, H. C.—Delivering Glass, 110
— — — Glass-blowing, 112
— — — and S. E. Winde.—Moulding Glass under Pressure, 112
— — — — Press-moulding Machine, 113
Davies, W. E.—Coke Ovens, etc., 11
Decorating Pottery. F. C. A. Tuhten, 89
Dederich W., and S. Willner—Liquid Fuel Burners, 69
Degelow, C.—Firing with Coal Dust; Solution of Fuel Question, 88
Delivering Apparatus. S. D. Olsen, 110
— Glass, 111
— Molten Metal. O. M. Tucker, W. A. Reeves and J. M. Beatty, 112
Demil, W. E. and W. M. McRobert.—Mechanical Stoking, 73
Dempster, J. R., G. F. H. Beard and G. W. Tooley—Gas Manufacture, 15
Denis, L.—Refractory Substances, 61
Density of Fireclay. E. M. Firth, F. W. Hodkin and W. E. S. Turner, 3
— of Soda-Magnesia Glasses. S. English and W. E. S. Turner, 37
Derneden, F.—Rotary Furnaces, 75
Design for Firebrick Plant. R. H. Minton, 21
"Deva" Flooring Tiles, 62
Diagrammatic Method of Calculating Ceramic Recipes. A. Pfoff and M. Donath, 61
Dilatometric Method for the Study of Transition Points. P. Braesco, 52
Dimitri, G. L.—Refractory Substances, 61
Discharging Device for Lime Kilns, etc., J. W. Teale, 72
— Lime Kilns. W. Fuchs, 73
— Shaft Furnaces. F. W. Bakema, 75
Discoloration Produced by Lead, Antimony and Arsenic in Lampworked Glass Tubing. F. W. Hodkin and W. E. S. Turner, 37
Disk Mills. V. Antoine, 92
Dispersoids. H. Plauson, 127
—: Colloid Powders. H. Plauson, 126
Dissipator Chimneys, 76
Distilling: Coking. M. J. Berg, 12
Dobble, J. A.—Liquid Fuel Burner, 69
Dobrudsha: Ceramic Discoveries in the — 128
Doll heads: Colouring — — 90
Dollinger, H.—Negligence in use of Wall Tiles of Best Qualities, 32
Donath, E.—Burning Lime with Coal with High Sulphur Content, 65
Dowson & Mason Gas Plant Co. Levenshulme and J. Paton. Tunnel Furnaces, 69
Drain Pipes: Salt-glazed — — 60
Drakebusch, W.—Slaking Lime mixed with Sand, 58
Draught Gauges: Importance of — — 76
— Regulating in Furnaces. G. H. Gibson, 11
— Trouble in Annular Kilns, 18
Dressler Tunnel Kiln. J. E. Sproat and D. Allbright, 14
— — Ovens Ltd. — Tunnel Kiln, 72, 73
Driers: Tunnel brick — T. Entwistle, 64
Dry Pressing. K. Dümmler, 63
Drying Chamber Utilizing Hot Air or Waste Gases. W. Eshardt & E. Hotop, 63
— China Clay. J. Adair, 3
— Machine. T. Allsop and W. W. Sibson, 64
— Sheds: Modern Open-air — — R. Seydel, 20
— Shrinkage of Fireclays. E. M. Firth, F. W. Hodkin and W. E. S. Turner, 3
Dufty, N. E.—see Vickers Ltd., 21
Dümmler, K.—Automatic Brick-cutters, 90
— — Dry pressing, 63
— — Fuel Consumption in Annular Kilns, 83
— — Hoffmann Kiln and its Prototype, 83
Dust and Smoke: Report of a Commission on — — Question, 84
—: Determination of — in Flue Gases of Annular Kilns for Burning Portland Cement. O. Schott, 18
—: Rock — Collecting, 52

E

Earhart, R. F.—Electrical Behaviour of Porcelain and Glass at Moderately High Temperature, 94
Earthenware : Firing of — H. J. Johnson, 72
— : Joints for — W. Hayhurst, 96
Earths : Rare — H. Sachse, 47
Eccentric Presses for Grog Bricks, 60
Eckardt, W., and E. Hotop—Drying Chamber utilising Hot Air or Waste Gases, 63
Eckert, H.—Buy Burned Lime according to its Calcium Oxide Content, 2
Economical Building Materials. Neumann, 39
Edge Mills, 90
Edifices for Cemeteries. G. Friese, 44
Edwards, W. H. and Edwards & Sons—Moulding Tea-cup Handles, 64
Eight-hour day in the Brick Industry. W. Matthies, 105
— — — Ceramic Industry. F. Sperber, 105
Eisenwerks Jagstfeld Ges. Blastheater for Gas Generators, 66
Electric Current : Effect of — — on Brickwork, 97
— Furnace Refractories. A. F. Greaves-Walker, 48.
— Furnaces. J. R. C. August, 73
— — D. F. Campbell, 68
— — P. de Mills, 74
— — E. L. Swalley, 70
— —: Refractories for — — 57
— Glass-melting Furnaces. O. Maetz, 11
— Insulation ; Plastic Compositions. E. F. A. Bultemann, 10
— Insulators. General Electric Co., 7
— — F. Jaentsch, 7
— — H. Lutz, 8
— — A. Renandin, 63
— — V. T. Tedeschi, 8
— —: Hand Stoneware Body for — — 60
— —: Method of Fixing Bodies in Hollow Cavities of Porcelain Objects by Shrinkage, for the Manufacture of — — in particular. H. Schomberg & Söhne, 60
— Lamp Bulbs : Forming — — E. Lecoultre, 37
— — : Glass for — — —. Corning Glass Works, 109
Electrical : Casting Heavy Porcelain Appliances for — Purposes, 60
— Behaviour of Porcelain and Glass at Moderately High Temperatures. R. F. Earhart, 94
Electrode Furnaces. See Furnaces
Empire Machine Co. Glass Drawing, 35, 36
— — — and B. D. Chamberlin—Glass Manufacture, 37
Enamel : Use of — in German Artificial Jewellery Industry. M. Hirzel, 19
Enamelling or Coating of Iron and Steel with Glass. R. F. Nailler, 19
Enamels. C. Musiol, 88
— and Glazes. E. Rietz, 88
— : Influence of Metallic Chorides on the Volatilization of Iron Oxides in — 9
Endell, K.—Behaviour of Refractory Bricks under Load at High Temperature, 98
Englehardt, W.—On Saving Coal, 76
Enzenauer, J.—Silica Bricks in Coke-oven Construction, 84
Engineers for Firing Technique in the Ceramic Industry. R. Clauss, 75
English, S., and W. E. S. Turner—Density of Soda-magnesia Glass, 37
Entwistle, T.—Tunnel Brick-driers, 64
Erdmenger, F.—Hollow Block Bricks, 40
Ermisch, P.—Government Control, 105
Ernst, H.—German versus Bohemian Brown Coal, 75
—, K.—Clay Cooking Utensils, 8
Établissements Rouchard et Lamassiaude —Brick Presses, 21
Etchells, H.—see T. H. Watson & Co., 12
Evans, W. E.—Improved Owen's Machine 111
Excavators. P. Mogel and H. O. Kurth, 92
— S. Templeton, 91
— : Clay and Marl — J. Strehl, 102
Extraction of Potassium from Felspar, 51
Extrusion Presses. G. E. Neuberth, 21

F

Fadden, W. J.—Lead Sulphate ; Zinc Oxide ; Furnaces, 16
Fabian, R.—Concrete Rings for Wells, 42
— — When is Concrete dry ? 42
Factory Organisation : Some general remarks on — — 103
Faience : Flourishing Period of Silesian — 128
Fairholme, F. C., W. H. Hatfield, and G. Stanfield.—Testing Hardness of Materials, 24
Falconar, C. L. — Moulding Concrete Blocks, 124
Fancy-ware Bodies and Glazes, 9
Fans : Steam-jet Blast *v.* Under-grate — L. Friedlander, 18
Fastings, J. S.—Rotary Kilns, 73
Faulty Casting of Porcelain. O. Rose, 11

Fawcett, H. A.—Carbonizing Apparatus, 16
Fedor, T. M.—Surface Leakage as a Factor in Insulator-design, 101
Feeder : Powdered-fuel Furnace — J. J. C. Boand, 66
Feeding Pulverulent-fuel Furnaces. J. E. Muhlfeld, 67
Feldenheimer, W.—see P. Schidrowitz, 51
Felspar : Extraction of Potassium from — 51
Fenton H., and A. W. H. Vivian—Rotary Kilns, 17
Ferguson, A.—Glass Furnace, 114
Ferric Oxide : Action of — — on Silica Bricks, 28
Ferro-concrete instead of Granite. T. Conring, 41
— — "Mats" for Canal Construction, 119
— — : Rusting of Iron in — H. Luftschitz, 40
— — Shipbuilding, 39, 119, 120
— — Tile Roofs. E. Neupert, 120
Fibro-Cement Products. R. V. Mattison, 7
Fidler, F., and J. C. Maxwell—Tunnel Kilns, 15
Filter Sand. G. Anklam, 1
Filtering Gases. N. Klarding, 69
Filterpress Frames. V. Kemp, 93
Finishing Machine for Jam-pots, etc. W. Ingam, 91
Fire Places in the Old City-Hall of Leipzig, 128
— proof Coatings of Plaster of Paris, 39
— Resisting Property of Limestone Concrete, 39
— Tests on Reinforced Concrete, 41
Firebrick Plant : Design for — — R. H. Minton, 21
Firebricks. T. W. Keillar, 96
— : Suitable — M. Kämpffer, 28
Fireclay Refractories under Load. A S. Watts, 23
Fireclays : Composition, Drying and Firing Shrinkage, Porosity and Density of British — E. M. Firth, F. W. Hodkin, and W. E. S. Turner, 3
— suitable for Glass Furnace Refractory Materials. E. M. Firth, F. W. Hodkin, and W. E. S. Turner, 3
Fired Colour of lime-containing Clays. Loeser, 83
Fireman : Annular Kiln — M. Grimm, 82
Firing : Application of Generator Gas — to the Ceramic Industry. K. Teichmann, 70
— : Ceramic — Process. K. M. Balley, 65
— China and Earthenware. H. J. Johnson, 72
Firing Hoffmann Kilns. R. Seydel, 17
— — — W. Matthes, 76
— Kilns with Wood from Tree-stumps, 11
—: Effect of — Period on the Vitrification of Clays. H. Sachse, 66
— Pottery : Practical Economies in — — E. Reutlinger, 70
— — Utensils in Annular Kilns. T. Klein 83
— Shrinkage of Fireclays. E. M. Firth, F. W. Hodkin and W. E. S. Turner, 3
— Stoneware Pipes. W. Schuen, 66
— Technique : Engineers for — — in the Ceramic Industry. R. Clauss, 75
— Temperatures Attainable with Wood. H. Sachse, 82
— with Artificial Draught. H. Sa., 66
— — brown Coal, 65
— — Coal Dust—Solution of Fuel Question. C. Degelow, 88
— : What happens during — R. Seydel, 66
— with Powdered Fuel, 11
Firth, E. M., F. W. Hodkin, and W. E. S. Turner—Composition, Drying and Firing Shrinkage, Porosity and Density of British Fireclays, 3
— : Fireclays suitable for Glass Furnace Refractory Materials, 3
Fischer—Air Cracks in Grog Products, 98
Fish Scaling. J. B. Shaw, 20
Floor Tiles : Preparation of Bodies for Stoneware — — E. Tuschhoff, 62
Flooring Brick : "Berra" new hollow — — F. Rücker, 60
— Tiles : "Deva" — — 62
Floors of Plaster. M. Neuhaus, 42
— — — for Granaries. B. Bosz, 42
Flower Pots. E. Tuschhoff, 64
— — : Manufacture of — — A. Harris, 63
Flue Gases : Determination of Amount of Dust in — — of Annular Kilns for Burning Cement. O. Schott, 18
Flusin, G.—Silica-Glass Industry, 114
Fluxes : Forgotten — G. Balltern, 9
Fours & Procédés Matby, Soc. Anon. Coke Ovens, 12
Francart, H.—Tunnel Furnaces, 74
— — Tunnel Kilns, 75
Fredl, G.—Trass and Portland Cement, 116
Frey, K. W.—Kaolin for Tannin Analysis, 56
Friction : New Facts about Surface — C. Terzaghi, 53
Friedlander, L.—Steam-jet Blast v. Under-grate Fans, 18
— — Under-grate Blowers, 66
Friese, G.—Edifices for Cemeteries, 44
Friesecke, A.—Standardization of Concrete Stoneware for Balustrades, 38

Frink, R. L.—Drawing Sheet Glass, 113
Fuchs, W.—Discharging Lime Kilns, 73
Fuel Consumption : Calculation in Mixed Burnings. G. Paschke, 18
— — in Annular Kilns. K. Dümmler, 83
—: Feeding pulverulent — Furnaces. G. E. Muhlfeld, 67
— : Gaseous — Furnace. T. G. Riley, 110
— : Liquid — Burner. H. Clements, 67
— — — J. A. Dobble, 69
— — — Soc. Anon. des Établissements Ballot, 69
— — — W. Dederich & S. Willner, 69
— — — for Steam Boilers. Ingold, 81
— Oils on Concrete : Effect of — — A. Guttmann, 116
— : Powdered — Furnace. Fuller Eng. Co., 66
— — — E. C. R. Marks, 73
— — — J. E. Kennedy, 67
— — — Feeder. J. J. C. Brand, 66
— : Liquid or Gaseous — Furnaces. R. J. Anderson, 72
— : — — used for Firing, 11
Fuels : Possible Utilization of Various — Baschant, 83
— : Utilization of Low-grade — 84
Fuller Eng. Co.—Powdered-Fuel Furnace, 66
Fuller-Lehigh Co.—Pulverising Mill, 93
Funk, W.—Glost-oven Porcelain Colours, 90
Furnace : Blast — Cement Goods. H. Passow, 118
— — Hearth. W. Mathesius, 83
—: British Fireclay suitable for Glass — Refractory Materials. E. M. Firth, F. W. Hodkin and W. E. S. Turner, 3
— : Calcining — A. Bigot, 75
— : — — A. V. Gowen-Lecesne, 73
— Charging. F. Clements, 69
— : Crucible — A. E. White, 68
— : Electric — Refractories. A. F. Greaves-Walker, 48
— : Electrode — D. F. Campbell, W. S. Gifford and H. S. Waite, 67
— : — — D. Luca, 72
— Feeder. T. R. Alexander, 70
— : Gaseous-fuel — T. G. Riley, 110
— : Gas-fired — ; New Type. M. W. Travers, 38
— : Glass — A. Ferguson, 114
— : — — H. Wilkinson, 110
— : — — W. J. Miller, 111
— : — — Soc. An. Verreries de Fauquez, 112
— : Glass melting —. L. Mount, 111
— Grates. H. C. Mann, 72
— Linings : Refractory and Protective Coating — — E. R. Stuwell, 81
Furnace : Muffle — C. F. Priest, 73
— : Oil-fired — A. A. Mohn, 110
— : Powdered-fuel — Fuller Eng. Co., 66
— : — — — J. E. Kennedy, 67
— : — — —Feeder. J. J. C. Brand, 66
— : Refractory Lining for Cupola — H. Geyer, 82
— Regenerators. A. B. Chantraine, 68
— : Rotating Muffle — J. R. C. August, 74
— Stoker. J. T. Johnson, 72
— Structures. J. H. Cumpsty, 75
— Temperature : Porosity and Volume Changes of Clay Fire Bricks at — — G. A. Loonies, 24
— Valves. Wellman Smith Owen, Eng. Corporation and A. V. Kemp, 67
Furnaces : Air and Draught Regulating in — G. H. Gibson, 11
— : Annealing — H. M. Thompson, 36
— etc. D. W. Anderson and A. D. Dabney, 12
— : Blast Apparatus for — H. Stansfield, 68
— : Delivery from Glass — J. Wolf, 112
— : Discharging Shaft — F. W. Bakema, 75
— : Electric — D. F. Campbell, 68
— : — — E. L. Swalley, 70
— : — — J. R. C. August, 73
— : — — P. de Miles, 74
— : — Glass-Melting — O. Maetz, 11
— : Electrode and Induction — J. R. Zubiria, 68
— : Electrode — Armour Fertilizer Works, 15
— : — — E. Assie, 15
— : — — Booth Electric Furnace Co. and J. R. Hall, 12
— : — — Br. Thomson-Houston Co. and H. Hastings, 67
— : — — G. Marsh, 15
— : — — M. L. Boillot and J. Dandignac, 15
— : — — Norwegian Firm, 13
— : — — Scovill Manufacturing Co. and M. H. Bennett, 15
— : — — T. H. Watson & Co., H. A. Greaves, H. Etchells, and W. Travers, 12
— : — — W. E. Moore, 68
— : Feeding Pulverulent-fuel — J. E. Muhlfeld, 67
— for Metal-heating, Glass, Pottery. J. R. C. August, 17
— : Glass — Corning Glass Works and J. Bailey, 36
— : — — Hartford-Fairmont Co., 110
— : — — J. S. Atkinson, Stein and Atkinson, and T. C. Moorshead, 36
— : — — Soc. C. Boucher et Fils, 37

Furnaces : Glass — W. L. Pratt, 109
— : — Melting — 18
— : Lead Sulphate; Zinc Oxide; — W. J. Fadden, 16
— : Lining Retorts and — S. A. McMinn, 12
— : Oil-Burner for — Soc. d'Utilisation des Combustibles Liquids, 73
— : Open Hearth — A. D. Williams, 76
— : — — — J. S. Shaw, 67
— : Powdered-fuel — E. C. R. Marks, 73
— : — Liquid or Gaseous Fuel — R. J. Anderson, 72
— : Refractories for Electric — 57
— : Regulating — E. McLean, 74
— : Retort — New Jersey Zinc Co., F. G. Breyer and E. H. Bunce, 13
— : Rotary — F. Derneden, 75
— : Tunnel — D. M. Cunningham, and Stein and Atkinson, 17
— : — — Dowson and Mason Gas Plant Co., Levenshulme and J. Paton, 69
— : — — H. Francart, 74
Fused Alumina for Abrasive purposes. Carborundum Co. 63
Fusible Mixtures of K_2O—CaO—Al_2O_3—SiO_2, 55

G

Gaehme.—Reinforced Concrete Staircase, 118
Gas-fired : Continuous — Kilns. C. F. Priest, 72
— Furnace ; New Type. M. W. Travers, 38
— Kiln. J. H. Marlow, 75
— firing : Application of Generator — — to Ceramic Industry. K. Teichmann 70
— Generators. J. H. Corthesy, 68
— — : Blast Heater for — — Eisenwerks Jagstfeld Ges., 66
— Mantle : Vitreosil — Protectors, 108
— Manufacture. C. E. Holt and T. Walker, 15
— — L. J. Terneden and P. J. Kummel, 17
— — R. and J. Dempster, G. F. H. Beard, and G. W. Tooley, 15
— Producer. Soc. Française de Travaux et Const. de Fours, 66
— Producers O. E. Yeo, 72
— Retorts. A. E. Whitcher, H. K. Hiller, and Hewitt Construction Syndicate, 12
Gaseous-Fuel Furnace. T. G. Riley, 110
Gases : Filtering — N. Klarding, 69
— : Kiln — and their Effect on Terra-cotta Glazes and Colours. F. B. Ortman, 14
Gasification of Peat in Generators wit Horizontal Rotary Grates. H Reiboldt, 18
Gaskell, T. H.—see E. Johnson, 92
Gathering Molten Glass ; Moulding und Pressure. M. J. Owens, 36
Gauges : Importance of Draught — 76
Gauthier, L.—Plastic Composition, 62
Gebauer—Bavarian Trass, 4
General Electric Co.—Composition o Porcelain, 10
— — — Electric Insulators, 7
Generator Gas-Firing : Application t Ceramic Indusry. K. Teichmann 70
Generators : Blast-Heater for Gas — Eisenwerks Jagstfeldt Ges., 66
— : — J. H. Corthesy, 68
— : Gasification of Peat in — with Hori zontal Rotary Grates. M. Reiboldt 18
Gerber, L.—Impervious Sand-Lime Bricks 28
— : V.—Aluminium Nitride, 2
Gerin, O. J.—Taylor System, 103
German Ceramic Industry : Substitutes fo Raw Materials in — — —. J. Klug,
— — Society, 44
— — —: First Meeting of — — — 128
— versus Bohemian Brown Coal. H Ernst, 75
Gey, F. J.—Moulds for Sleepers, 92
Geyer, H.—Development of Refractory Industry in General, 102
— — Refractory Lining for Cupola Fur-naces, 82
Gibson, G. H.—Regulating Air Supply and Draught of Furnaces, 11
Gifford, D. F.—see D. F. Campbell, 67
Glass, A. M.—Glass Moulds, 109
— and Ceramic Industry : Situation in the German — — 103
— at High Temperatures, Measurements of Thermal Dilatation. C. G. Peters and C. H. Gragoe, 106
— Bars : Cutting or Severing — — Libbey Glass Co. and E. Danner, 36
— : Batches for Laboratory — 34
— Beads : Moulding — — W. Haunich, 33
— Blowers. W. J. Jackson, 110
— Blowing. A. R. Hunter, 110
— — H. C. Daubenspeck, 112
— — J. Baldermann, 33
— — J. Macluskie, 37
— — J. T. Pullon, 36
— — Machines. W. J. Miller, 36, 109
— Bottle Industry, Labour Economy and Increased Output, 35
— — Machines. T. Berger, 109
— : Bubbles in — 32

Glass : Calculation of Hardness, or Expansion of — L. Springer, 34
— : Casting Pots for Optical — A. B. Taylor, 37
— : Circular Flattening Ovens and Lehrs for Plate — C. Baldermann, 108
— : Coloured — K. Warga, 112
— : Cutting — C. Zeiss, 114
— Cylinders. E. C. R. Marks, 114
— — : Drawing — — E. C. R. Marks, 111
— Decorating Methods. C. Jung, 34
— : Delivering — H. C. Daubenspeck, 110
— : — Molten — Hartford-Fairmont Co., 113
— : — — — — — — — and E. H. Lorenz, 36
— : — — — R. T. McGee, 111
— Drawing. Empire Machine Co., 35,36
— —: Virginia Plate Glass Corporation and A. A. Icenhour, 35
— : — Sheet — R. L. Frink, 113
— : Electrical Behaviour of Porcelain and — at Moderately High Temperatures. R. F. Earhart, 94
— for Casing : Copper-ruby — — — J. Baldermann, 108
— — Electric Lamp Bulbs. Corning Glass Works, 109
— : Frosted — T. Ueda, 109
— Furnace. A. Ferguson, 114
— — H. Wilkinson, 110
— — Soc. An. Verreries de Fauquez, 112
— — W. J. Miller, 111
— — Refractory Materials ; British Fireclays suitable for — — E. M. Firth, F. W. Hodkin, and W. E. S. Turner, 3
— Furnaces. Corning Glass Works and J. Bailey, 36
— — Hartford-Fairmont Co., 110
— — J. R. C. August, 13
— — J. S. Atkinson, Stein and Atkinson, and T. C. Moorshead, 36
— — Soc. C. Boucher et Fils, 37
— — W. L. Pratt, 109
— — : Delivery from — — J. Wolf, 112
— : Gathering Molten — M. J. Owens, 36
— : Grinding and Polishing Plate — Pilkington Bros., 113
— Industry : Lead — — V. Hannick, 33
— — : Peat for — A. F. Wuromus, 18
— — : Situation in the Swiss — 103
— —: Thermo-Technical Advice for the German — — 128
— Manufacture. E. Danner, 113
— — E. H. Langwell, 36
— — Empire Machine Co. and B. D. Chamberlain, 37
— — F. O'Neill, 109
— — M. Mathy, 37
— — Schlesische Spiegelglas-Manufaktur C. Tielsch Ges., 109
Glass Manufacture. W. J. Miller, 37, 113
— — Wilcox Machine Co., 112
— : — of Mother-of-Pearl — O. Schwarzenbach, 33
— — : Phonolite in — — 33
— Melting : Electric — Furnaces. O. Maetz, 11
— Mould Machine. W. J. Miller, 111
— Moulding. L. Mount, 112
— — Under Pressure. H. C. Daubenspeck and S. E. Winder, 112
— — — M. J. Owens, 36
— Moulds. A. M. Glass, 108
— : Optical — Development during the War. C. J. Peddle, 38
— : Orange-coloured Plate — 109
— Ovens and Tanks : Grog Bricks for Building — — — J. Baldermann, 58
— : Plate — Manufacturer. J. Ramsey, 111
— Pots : Dimensions of — — J. Baldermann, 35
— — : Effect of Cryolite on — — 35
— — : Lining for — — S. R. Scholes, 35
— — : Melting Process in Low — — J. Baldermann, 33
— : Removing Bubbles from Molten — Schott & Gen, 112
— Rods : Sorting — — E. C. R. Marks, 111
— : Roumanian — Industry, 31
— Shears. W. J. Jackson, 112
— : Silica — Industry. G. Flusin, 114
— Melting Furnaces, 18
— : Soda, Lime, and Magnesia Content of — C. C. Rand, 33
— : Spun — C. Muth, 113
— : — — G. Pazsiezky, 113
— : Sulphate-Waterglass Mixtures as Substitutes for Alkali in — Batch. L. Springer, 38
— Surfaces : Coating — — Br. Thomson-Houston Co., 111
— Tubing : Discoloration Produced by Lead, Antimony, and Arsenic in Lampworked — — F. W. Hodkin and W. E. S. Turner, 37
— : Use of Sodium Sulphate for making A1 Crystal — K. Killer, 34
Glasses : Density of Soda-Magnesia — S. English and W. E. S. Turner, 37
Glass-melting Furnace. L. Mount, 111
Glassware : Polishing — R. Haddan, 111
Glaze : Effect of Zinc on Chrome-Green — 19
Glazed Bricks : Cracking and Scaling of — W. Pukall, 88
— Face-Tiles : White — — Hasak, 88
— Retorts : Prevention of Cracking, 62
— : Salt — Drain Pipes, 60

Glazes : Enamels and — E. Rietz, 88
— : Fancy-Ware Bodies and — 9
— : Method of Preparing Leadless — 88
— : Prevention of Devitrification of — R. Berg, 19
— : Slip — R. Richter, 20
— : Terra-cotta — and Colours. F. B. Ortman, 14
Glendinning, J. A.—Concrete Pipes, 121
Glost-oven Porcelain Colours. W. Funk, 90
Göhring, H.—Profit Sharing, 30
Gonnoske Komai. — Japanese Ceramic Industry, 129
Government Control. P. Ermisch, 105
Gowen-Lecense, A. V.—Calcining Furnace, 73
Grading of Refractory Bricks. O. Böndel, 96
— — — Products, 95
Gragoe, C. H.—see C. G. Peters, 106
Granaries : Plaster Floors for — B. Bosz, 42
Granite : Ferro-concrete instead of — T. Conring, 41
Grate : Rotary — L. Tréfois, 69
Grates : Furnace — H. C. Mann, 72
— : Reconstruction of — for Firing with Lignite and Briquettes. O. Schöne, 65
Gravel and Sand : Washing and Screening Plant for — — Wetzel, 93
Greaves, H. A.—see T. H. Watson & Co., 12
Greaves-Walker, A. F.—Electric Furnace Refractories, 48
Grey, R. B.—Mixing, 20
Grimm, M.—Annular Kiln Fireman, 82
Grinding and Polishing Plate Glass. Pilkington Bros., 113
— Mill. H. T. Rudisill, 92
— — : Sifter for — — E. E. Bentall and G. C. Bingham, 93
"Gripping" Property of Concrete on Iron, 117
Grog, 62
— Bricks : Eccentric Presser for — — 60
— — etc. for Building Glass Ovens and Tanks. J. Baldermann, 58
— Products : Air Cracks in — — Fischer, 98
— Ware : Manufacture of — — 59
Grossheim.—Concrete Tank for Ammonia Water, 117
— Light Plaster Bricks, 58
Grossley, P. B.—Artificial Stone, 114
Grout, F. F.—Clays and Shales of Minnesota, 1
Grün, R.—Simple Apparatus for Testing Cement, 118
Grüneisen—Taylor System and the Brick Industry, 31
Guillery, R.—Testing Physical Qualities of Materials, 24
Guillot, P. J.—Artificial Marble, 120
Guttmann, A.—Effect of Fuel Oils on Concrete, 116
György, P.—see P. Rona, 54
Gypsum : Ammonium Sulphate from Rock — 51
— as Substitute for Putty. G. Atterburg, 117
— Moulds for Interlocking Tiles. Baschant, 60
— : Recovery of Sulphur from — L. Martin, 124
Gyratory Crushers. Smith Eng. Works, 91

H

Haddan, A. J. H.—Moulds, 114
— — — Receptacles for Blow-irons, 111
— R.—Polishing Glass-ware, 111
— — — Removing Articles from Blow-Iron, 113
Hadfield, R. A.—Conveying and Screening Apparatus, 93
Haerting, H.—Artificial Marble, 118
— — Behaviour of Ultramarine in Cement, 118
Hänse, W.—War-time Lime Kiln, 81
Hall, G.—Phthisis in Lime Works, 45
— J. R.—see Booth Electric Furnace Co. 12
Hamburg State Building. C. Zetzsche, 127
Hamilton, H. A. and F. J. Twigg—Moulds for Concrete Blocks, 124
Handles : Moulding Teacup — W. H. Edwards & Edwards & Sons, 64
Hanel, G.—Rough and Face Bricks v. Plastering, 40
Hannick, V.—Lead Glass Industry, 33
Hardening Artificial Stone. C. H. Schol, 120
Hardinage, H. W.—Ball Mills, 91
Hardness of Materials : Testing — — L. Johnson and H. Brearly, 24
— or Expansion of Glass : Calculation of — — L. Springer, 34
— testing Machines. W. & T. Avery and H. W. Cox, 24
— — of Materials. F. C. Fairholme, W. H. Hatfield and G. Stanfield, 24
— — — — P. J. Steinke, 96
Harris, A.—Manufacture of Flower Pots, 63
Harrison, J. H.—Casting Concrete, 120
Hartford-Fairmont Co. Delivering Molten Glass, 113

Hartford-Fairmont Co. Glass Furnaces, 110
— — — and E. H. Lorenz.—Delivering Molten Glass, 36
Hasak—Bavarian Brick Structures of the Romanesque Period, 128
— D.—Brandenburg Cathedral, 128
— Roman Burnt-Brick Structures, 129
— White Glazed Face-tiles, 88
Hastings, H.—see British Thomson-Houston Co., 67
Hatfield, W. H.—see F. C. Fairholme, 24
Haunich, W.—Moulding Glass Beads, 33
Hayhurst, W.—Joints for Earthenware, 96
Hearth : Blast-furnace — W. Mathesius, 83
Heat Conductivity and Specific Heat of Refractory Products, 28
— Insulating Materials. International Insulations Co., 10
— Saving Arrangements of Revolving Tubular Kilns. E. Schott, 76
— — Investigations on Kilns. E. Reutlinger, 70
— : Utilisation of Waste — in Annular Kilns. R. Rieke, 64
Heating : Efficient — of Public Buildings, 84
Heck, C.—Prime Colour Ceramic Photography, 20
Heinecke, E.—Ceramic Metal-technique, 20
— — My Experiences in Ceramics, 44
"Herda" Kiln, 66
Hessel, K.—Moulding Building Blocks, 122
Hewitt Construction Syndicate. See A. E. Whitcher, 12
Heyer, G.—Coal Saving Brick Production, 8
Hielscher—Crushing Strength of Full and Perforated Bricks, 98
— A.—Hollow-brick Question, 58
High-tension Insulator Porcelain. W. D. A. Peaslee, 100
Hillebrand, W. F.—Analysis of Silicate and Carbonate Rocks, 42
Hiller, H. K.—see A. E. Whitcher, 12
Hirsch.—Unburned Bricks, 7
Hirzel, M.—Use of Enamel in German Artificial Jewellery Industry, 19
Hoare, T. F.—Casting Slag, 11
— — — Utilizing Slag, 7
Hodkin, F. W. and W. E. S. Turner—Discoloration Produced by Lead, Antimony and Arsenic in Lampworked Glass Tubing, 37
— — — See E. M. Firth, 3
Hoffmann Kiln and its Prototype. K. Dümmler, 83
— Kilns. R. Seydel, 17
— — : Coke for — — Loeser, 17
— — : Firing of — 76
Hollow Block Bricks. F. Erdmenger, 40
— brick Question. A. Hielscher, 58
— bricks : Manufacturing Costs for Full and Hollow-bricks, 105
— — the Future Building Material. L. Schmelzer, 8
— Concrete Blocks ; Size of — — 40
— ware : Moulding — — L. Cucurny y Sanmarti, 64
Holt, C. E. and T. Walker—Gas Manufacture, 15
Hot Method of Preparing Sand-lime Brick Bodies (Schwarz Machine). H. Jolig, 93
Hotop, E.—see W. Eckardt, 63
Huart, A.—Brick Machines, 21
Hüther, G.—Manufacturing Costs in Brick Industry, 31
Hungarian Bauxites, 2
Hunter, A. R.—Glass Blowing, 110
Hurden, E.—see J. A. Cann, 121
Hydraulic Lime : Manufacture of — — G. Lefevre, 119
Hygiene of the Ceramic Industry. B. Schoeber, 129

I

Icenhour, A. A.—see Virginia Plate Glass Corporation, 35
Impervous Sand-lime Bricks. L. Gerber, 28
Industriewerke—See A. Muller Bauten, 22
Industry : Eight Hour Day in the Brick — W. Matthes, 105
— : — — — in the Ceramic — F. Sperber 105
— : Problems of the Porcelain — F. Singer, 104
Ingam, W.—Finishing Machine for Jampots, etc, 91
Ingold.—Liquid Fuel for Steam Boilers, 81
Insulating Materials : Heat — — International Isolations Co., 10
Insulation : Electric — E. F. A. Bultemann, 10
Insulator Design : Surface Leakage as a Factor in — — T. M. Feder, 101
— : High Tension — Porcelain. W. D. A. Reaslee, 100
Insulators : Electric — A. Renandin, 63
— : — — F. Jaentsch, 7
— : — — General Electric Co., 7
— : Electric — H. Lutz, 8
— : — — V. Tedeschi, 8

Insulators: Hard Stoneware Body for Electric — 62
— : Method of Fixing Bodies in Hollow Cavities for Porcelain Objects by Shrinkage, for the Manufacture of Electric — H. Schomburg & Söhne, 60
— : Porcelain — O. Boudouard, 100
Internal Forces: Measurement of — — by Optical Methods. H. Schulz, 43
International Isolations Co.—Heat Insulating Materials, 10
Introduction to Ceramics. A. Berge, 44
Ionides, A. C.—Tunnel Kilns, 13
Iowa Clays: Possibilities of Pottery Manufacture from — — W. G. Whitford and O. J. Whittemore, 4
Iron-ore: Bog — — 51
— Oxide: Volatilization of — — in Enamels, 19
— : Rusting of — in Ferro-concrete. H. Luftschitz, 40
Iyengar, P. S.—Some Kaolin and Clay Occurrences in the Koppa Taluk, 50

J

Juster, B.—Works' Councils and Trade Unions, 104
Jacer, H.—Clay as a Remedy, 45
Jackson, W. J.—Glass Blowers, 110
— — — Shears, 112
Jacob, K.—Roumanian Stoves, 18
Jaentsch, F.—Electric Insulators, 7
Jaeger, G.—Mixing Apparatus, 124
Jaeger, D.—Artificial Marble, 123
Jam-pots: Finishing Machine for — — W. Ingam, 91
Japanese Ceramic Industry. Gonnoske Komai, 129
— Fine Ceramic Industry, 127
Jews' Porcelain. A. Kunth, 128
Johnson, E., T. H. Gaskell and W. Boulton, Ltd.—Pug-mills, 92
— H. J.—Firing China and Earthenware, 72
— J. Y.—Furnace Stoker, 72
— L. and H. Brearley—Testing Hardness of Materials, 24
Joints for Earthenware. W. Hayhurst, 96
Jolig, H.—Hot Method of Preparing Sand-lime Brick Bodies (Schwarz Machine) 93
— — Street Paving with Sand-lime Bricks 95
Jollies. Aktiebol. Gustafsberg-Fabriks-Inter., 92
— J. L. Wakefield, 91
Jolleying. C. Baggley, 92
Jung, C.—Glass-decorating Methods, 34
Jordt, H.—Manufacture of Tiles from Clays containing Lime, 9

K

Kampffer, M.—Suitable Firebricks, 28
Kaolin, 48
— and Clay Occurrences in the Koppa Taluk. P. S. Iyengar, 50
— : Ceramic and Paper — 48
— : Clay and — Works of Saxony, 44
— for Tannin Analyses. K. W. Frey, 56
— : Prospecting for — in the Koppa Taluk. B. Balaji Roo, 5
— Works: Clay and — — in Saxony, 127
Keel, E.—Moulding Hollow Concrete, 122
Keillar, T. W.—Firebricks, 96
Kemp, V.—Filter-press Frames, 93
— A. V.—see Wellman Smith Owen Eng. Corporation, 67
Kennedy, J. E.—Ball and like Mills, 91
— — — Powdered Fuel Furnace, 67
— — — Retorts, 16
— — — Roller-and-ring Mills, 91
Kerb-stones: Concrete — 39
Kien, R.—Refractory Material used in Chemical Industry, 47
Kierling, C. A.—Mechanical Efficiency of Brick Presses, 22
Kieselguhr, Leisteres, 47
Killer, K.—Use of Specially Purified Sodium Sulphate for making Al Crystal Glass, 34
Killing, G.—see Westf. Gasglühlicht-Fabrik, 68
Kiln Control, 83
— : Dressler Tunnel — J. E. Sproat and D. Allbright, 14
— Fireman: Annular — — M. Grimm, 82
— Firing with Wood from Tree-stumps, 11
— Gases and their Effect on Terra-cotta Glazes and Colours. F. B. Ortman, 14
— : Gas-fired — J. H. Marlow, 75
— "Herda" — 66
— : Hoffmann — and its Prototype. K. Dümmler, 83
— : Thermal "Balance Sheet" of an Annular — R. Claus, 66
— : Tunnel — Dressler Tunnel Ovens, Ltd. 72
— : War-time Lime — W. Hänse, 81
— : Zehner's "Reform" — for Small Works, 84
Kilns: Annular — R. Seydel, 18
— : Brick — A. Sharratt, 14
— : — — A. W. F. Weigers, 68
— : — — T. West, 72
— : Carriers for Tunnel — R. C. Metcalfe, 75

Kilns : Charging — G. A. Collins, 73
— : Coal-saving Method of Firing Annular — P. Thor, 82
— : Coke for Hoffmann — Loeser, 17
— : Continuous Gas-fired — C. F. Priest, 72
— : Cost of Burning Magnesite in Electrically Heated — W. F. Smeeth, 53
— : Determination of Dust in Flue Gases of Annular — for Burning Cement. O. Schott, 18
— : Discharging Device for Lime — J W. Teale, 72
— : — Lime — W. Fuchs, 73
— : Draught Trouble in Annular — 18
— : Dressler, — Dressler Tunnel Ovens Ltd., 73
— : Economic Working of Porcelain — F. Rohrwasser, 17
— : Firing Hoffmann — R. Seydel, 17
— : — — — W. Matthies, 76
— : — Pottery Utensils in Annular — T. Klein, 83
— : Fuel-consumption in Annular — K. Dümmler, 83
— : Heat Saving Arrangement of Revolving Tubular — E. Schott, 76
— : — — Investigations on — E. Reutlinger, 70
— : Lime — C. Caudlot, 73
— : — — W. Somerville, 73
— : Repair Work in the Combustion Chamber of Annular — 84
— : Rotary — H. Fenton and A. W. H. Vivian, 17
— : — — J. S. Fastings, 73
— : Tunnel — A. Bigot, 73
— : — — A. C. Tonides, 13
— : — — C. H. Zwermann, 16
— : — — C. Whitfield, 72
— : — — F. Fidler and J. G. Maxwell, 15
— : — — G. H. Benjamin, 16, 67
— : — — H. Francart, 75
— : — — R. C. Metcalfe, 72, 75
— : — — T. Teisen, 68
— : Utilisation of Ashes from Porcelain and Earthenware — M. Sauer, 64
— : — — Waste Heat in Annular — R. Rieke, 64
— : Zigzag — 76
Kirchheim, E.—Utilization of Plaster Moulds, 98
Klarding, A.—Filtering Gases, 69
Klehe, T.—Rapid Method of Analysis for Portland Cement, 125
Klug, J.—Substitutes for Foreign—particularly English—Raw Materials in Germany, 1
Klein, T.—Firing Pottery Utensils in Annular Kilns, 83
Kleine, J. F.—Re-organisation of Brick Industry, 31
Koerner—Proper Appreciation and Remuneration of Scientific Work in the Ceramic Industry, 103
Koppa Taluk : Kaolin and Clay Occurrences in the — 50
Kosmann, B.—Slaked Lime and Milk of Lime, 53
Krieger, B.—Lime and the Sand-lime Brick Industry, 102
— — Sand for Sand-lime Bricks, 1
— — The Neuss Sand-lime Brick Works, 58
Kroker.—Concrete Roofing Tiles, 39
Kuhn, G.—Moulding Hollow Blocks, 121
Kummel, P. J.—see L. J. Terneden, 17
Kunth, A.—Jews' Porcelain, 129
Kurth, H. O.—see P. Mogel, 92

L

Laboratory Glass : Batches for — — 34
Labour Economy and Increased Output in Bottle Making Industry, 35
— Saving Devices in the Brick Making Industry. Baschant, 83
Lanzer Ware. J. Ley, 44
Lamp Bulbs : Finishing — — Br. Thompson-Houston Co., 111
Lampworked Glass Tubing : Discoloration produced by Lead, Antimony, and Arsenic in — — — F. W. Hodkin and W. E. S. Turner, 37
Langwell, E. H.—Glass Manufacture, 36
Larsen, A.—Cements and Mortars, 124
Lathes : Driving Potters' — C. J. Robinson, 91
Lead Glass Industry. V. Hannick, 33
— Sulphate : Zinc Oxide ; Furnaces. W. J. Fadden, 16
— Glaze Pottery in Silesia and Saxony. K. Strauss, 128
Leadless Glazes : Method of Preparing — — 88
Leakage : Surface — as a Factor in Insulator Design. T. M. Fedor, 101
Lechat, E.—Moulding Concrete Blocks, 121
Lecoultre, E.—Gathering Molten Metal ; Blowing ; Forming Electric Lamp Bulbs, 37
Lefevre, G.—Manufacture of Hydraulic Lime, 119
Leisteres—Kieselguhr, 47
Lerg, J.—Ceramics for Cemeteries, Tombstones, etc., 44
— — Läuger Ware, 44
Lesley, R. W.—Making Portland Cement, 123

Lesson : Object — Oesterling, 102
"Leukolith," a Mortar made from Anhydrite. H. E. Sachse, 117
Level Crossing covered with Concrete, 39, 40
Libbey Glass Co. and E. Danner—Cutting Glass Bars or Tubes, 36
Lignite and Briquettes : Reconstruction of Grates for Firing with — — O. Schöne, 65
Lime and the Sand-lime Brick Industry. B. Krieger, 102
— as Lubricant, 4
— : Burning — with Coal with High Sulphur Content. E. Donath, 65
— : Buy Burned — according to its Calcium Oxide Content. H. Eckert, 2
— : Carbide — as a Building Material, 52
— Kiln : War-time — — W. Hänse, 81
— Kilns. C. Caudlot, 73
— — W. Somerville, 73
— — : Discharging — — W. Fuchs, 73
— — : — Device for — — J. W. Teale, 72
— : Manufacture of Hydraulic — and Natural Cement. G. Lefevre, 119
— : Slaked — and Milk of Lime. B. Kosmann, 53
— : Slaking — Mixed with Sand. W. Drakebusch, 58
— Works : Phthisis in — — G. Hall, 45
Lime-containing Clays : Fired Colour of — — Loeser, 83
Limestone Concrete : Fire-resisting Property of — — 39
Lining for Glass Pots. S. R. Scholes, 35
— : Refractory — for Cupola Furnaces. H. Geyer, 82
— Retorts and Furnaces. S. A. McMinn, 12
Link, E.—Concrete and Mortars, 120
Liquid Fuel—see Fuel
Loeser.—Coke for Hoffmann Kilns, 17
— Fired Colour of Lime-containing Clays, 83
Loomes, G. A.—Porosity and Volume Changes of Clay Fire Bricks at Furnace Temperature, 24
Loosi, H.—see W. North, 50
Lorenz, E. H.—see Hartford-Fairmont Co., 36
Lovell, C. P.—Building Blocks, 60
Lubricant : Lime as — 4
Lubricants : Testing — 126
Luca, D.—Electrode Furnace, 72
Luftschitz, H.—Gripping Power of Cement 41
Lutz, H.—Electric Insulators, 8
Luftschitz, H.—Rusting of Iron in Ferro-concrete, 40

M

McDowell, N. A. M.—Moulding Concrete Blocks, 120, 122
McGee, R. T.—Delivering Molten Glass, 111
Machine : Finishing — for Jam-pots, etc. W. Ingam, 91
— for Brick-cutting. W. Smith, 91
— : Ramming — for Cement Goods, 94
Machinery : Care of — K. Wachwitz, 22
Machines for Bricks. W. J. Todd, 90
— — — Making. P. Piesnack, 90
— — Testing Hardness. W. & T. Avery and H. V. Cox, 24
McLean, E.—Regulating Furnaces, 74
Macluskie, J.—Glass-blowing, 37
McMinn, S. A.—Lining Retorts and Furnaces, 12
McRobert, W. M.—see W. E. Demil, 73
Maetz, O.—Electric Glass-melting Furnaces, 11
Magnesia : Tests on the Air-slaking of — Calcined at Various Temperatures. A. M. Sen, 54
Magnesite : Cost of Burning — in Electrically Heated Kilns. W. F. Smeeth 53
Maier, E.—Reinforced Concrete, 122
Malinite Process for Making Refractory Sillimanite. H. Sachse, 58
Mann Egerton & Co.—Indicating Progress of Work, 106
— H. C.—Furnace Grates, 72
Mantle Protectors : Vitreosil Gas — — 108
Manufacturing Costs for Full and Hollow Bricks, 105
— Statistics, 30
Marble : Artificial — D. Jager, 123
— : — — K. Haerting, 118
— : — — P. J. Guillot, 120
Marcusson, J.—Proofing Concrete, 120
Mark, E. C. R.—Sorting Glass Rods, 111
— — — — Drawing Glass Cylinders, 111
— — — — Glass Cylinders, 114
— — — — Powdered Fuel Furnaces, 73
Marl and Clay Excavators. J. Strehl, 102
Marlow, J. H.—Gas-fired Kiln, 75
Marques, C.—Moulding Concrete Blocks, 123, 124
Marsh, G.—Electrode Furnaces, 15
Martin, L.—Recovery of Sulphur from Gypsum, 124
Materials : Raw — 47
Mathesius, W.—Blast Furnace Hearth, 83
Mathy, M.—Glass Manufacture, 37
Matthes, W.—Eight-hour Day in the Brick Industry, 105
— — Firing of Hoffmann Kilns, 76

Matthies, K.—Standardisation in the Brick Industry, 31
Mattison, R. V.—Fibro-cement Products, 7
Maxwell, J. G.—see F. Fidler, 15
Measurement of Internal Forces by Optical Methods, H. Schulz, 43
Measurements of the Thermal Dilatation of Glass at High Temperatures. C. G. Peters and C. H. Cragoe, 106
Mechanical Appliances in Fine-ceramic Works. A. Saner, 90
— Stoker. G. A. Revermann, 73
— Stoking. W. E. Demil and W. M. McRobert, 73
Melting Process in Low Glass Pots. J. Baldermann, 33
Metal Coatings. H. Welte, 7
— heating : Furnaces for — J. R. C. August, 17
— technique : Ceramic — E. Heinecke, 20
Metallic Coatings : Method of Applying — — to Artificial Stone. Schonlau, 119
— Chorides : Influence of — — on the Volatilization of Iron Oxide in Enamels, 19
Metcalfe, R. C.—Carriers for Tunnel Kilns, 75
— — — Tunnel Kilns, 72, 75
Mill : Grinding — H. T. Rudisill, 92
— : Pulverising — Fuller-Lehigh Co., 93
— : — — H. Cramm, 93
Millard, C. C., R. A. Robertson and C. J. Cooper.—Bricks, 10
Mill : Ball — H. W. Hardinge, 91
— : — — J. R. Bradley, 91, 92
— : — and like — J. E. Kennedy, 91
— : Edge — 90
— : Pug — E. Johnson, T. H. Gaskell and W. Boulton, Ltd., 92
— : Disk — V. Antoine, 92
— : Roller-and-ring — J. E. Kennedy, 91
Milde, A.—Wages Question in the Brick Industry, 102
Miles, P. de.—Electric Furnaces, 74
Millar, W. J.—Glass Manufacture, 37
Miller, W. J.—Bottle Blowing Machine, 114
— — — Glass-blowing Machines, 36, 109
— — — — Furnace, 111
— — — — Manufacture, 113
— — — — Mould Machine, 111
Minerals and Rocks : Colorimetric Tests for — — W. Zwieg, 42
Minnesota Clays and Shales. F. F. Grout, 1
Minton, R. H.—Design for Firebrick Plant, 21
Mitchell, W. H.—Tea-pots, Coffee-pots, etc., 63
Mixing. R. B. Grey, 20
— W. J. Coles and E. Allen & Co., 21
— Apparatus. G. Jaeger, 124
— : Mortar — Machines, 39
Modelling Compositions. E. J. Buckley, 10
Mogel, P. and H. O. Kurth—Excavators, 92
Mohn, A. A.—Oil-fired Furnaces, 110
Molten Glass : Delivering — — Hartford-Fairmont Co. and E. H. Lorenz, 36
— Metal : Delivering — — J. D. Roots, 114
— — : — — — O. M. Tucker, W. A. Reeves and J. M. Beatty, 112
— — : Gathering — — E. Lecoultre, 37
— — : Shearing — — O. M. Tucker and W. Reeves, 112
Moore, W. E.—Electrode Furnaces, 68
Moorshead, T. C.—see J. S. Atkinson, 36
Morris, A. P.—Ornamenting Pottery, 90
Mortar and Cement : Spraying Process for — — 40
— : Influence of — on Wall Strength. Sasse, 117
— : "Leukolith." H. E. Sachse, 117
— Mixing Machines, 39
— Spraying Machine, 119
Mortars and Cements. A. Larsen, 124
— — Concretes. F. L. Smidth & Co., 38
— : Chamotte — F. Boehring, 41
— : Refractory — E. Trab, 42
"Mother-of-Pearl" Glass : Manufacture of — — O. Schwarzbach, 33
Moulding Building-blocks. C. H. Schol, 60
— — J. Stephenson, 91
— — K. Hessel, 122
— Bricks. C. W. Bosher, 60
— — Blocks, etc. G. C. Thomas, 92
— by Centrifugal Force. Vickers, Ltd., and N. E. Dufty, 21
— Cement Blocks. Aktiebolaget Lean, 122
— — Pipes. A. O. Crozier, 122
— — T. J. McDowell, 120
— Concrete Blocks. A. Young, 124
— — — C. Marques, 124
— — — E. Lechat, 121
— — — E. L. Warren and W. J. Parker, 122
— — — G. L. Falconar, 124
— — — J. M. Wellington and D. G. Mackenzie, 123
— — — M. C. A. Brissart, 124
— : Glass — L. Mount, 112
— — Beads. W. Hannich, 33
— — under Pressure. H. C. Daubenspeck, and S. E. Winder, 112
— — — M. J. Owen, 36

Moulding Hollow Blocks. G. Kuhn, 121
— — Concrete Blocks. E. Keel, 122
— — ware. L. Cucurny y Sanmarti, 64
— Machine. Soc. Le Basalte, 92
— — for Concrete Blocks. N. A. M. McDowell, 122
— —: Press — — H. C. Daubenspeck and S. E. Winder, 113
— Slabs, etc. C. J. Ross, 121
— Teacup Handles. W. H. Edwards and Edwards & Sons, 64
— Tiles. A. Muller Bauten and Industriewerke, 22
Moulds. A. J. H. Haddon, 114
— J. Wallace, 92
— Soc. Le Basalte, 92
—: Bottle Machine — T. Berger, 109
— for Concrete Blocks. H. A. Hamilton and F. J. Twigg, 124
— for Sleepers, etc. F. J. Gey, 92
—: Glass — A. M. Glass, 109
—: — — Machine. W. J. Miller, 111
—: Gypsum — for Interlocking Tiles. Baschant, 60
—: Utilization of Old Plaster — E. Kirchheim, 98
Mount, L.—Glass-melting Furnace, 111
— — Glass Moulding, 112
Muffle-furnace. C. F. Priest, 73
— —: Rotating — — J. R. C. August, 74
Muhlfeld, J. E.—Feeding Pulverulent Fuel Furnaces, 67
Muller Bauten, A. and Industriewerke.—Moulding Tiles, 22
Musiol, C.—Enamels, 88
Muth, C.—Spun Glass, 113

N

Nailler, R. F.—Enamelling or Coating of Iron and Steel with Glass, 19
Negligence in the use of Wall Tiles of Best Quality. H. Dollinger, 32
Neuberth, G. E.—Extrusion Presses, 21
Neuhaus, G.—Peculiar Phenomenon, 44
— M. Plaster Floors, 42
Neumann—Economic Building Materials, 39
Neupert, E.—Ferro-concrete Tile Roofs, 120
Neuss Sand-lime Brick Works. B. Krieger, 58
New Jersey Zinc Co., F. G. Breyer and E. H. Bunce.—Zinc Oxide; Retort Furnaces, 13
Norske Akt. Elektrokemisk Ind.—Treating Slag, 60
North, W., and H. Loosli.—Zirconium, 51
Norwegian Firm—Electrode Furnaces, 13
— — Treating Slag, 10
Noteworthy Buildings of East and West Prussia. C. Sickel, 44

O

Object Lesson. Oesterling, 102
Oil-burner for Furnaces. Soc. d'Utilisation des Combustibles Liquids, 73
— fired Furnace. A. A. Mohn, 110
— Purifier, 94
Oils and Lubricants: Testing of — — 126
—: Effect of Fuel — on Concrete. A. Guttmann, 116
Olsen, S. D.—Delivering Apparatus, 110
O'Neill.—Glass Manufacture, 109
Open Hearth Furnaces. A. D. Williams, 78
Optical Glass: Casting Pots for — — A. B. Taylor, 37
— —: Development during the War. C. J. Reddle, 38
— Methods: Measurement of Internal Forces by — — H. Schulz, 43
Orange Coloured Plate Glass, 108
Organisation: Some General Remarks on Factory — 103
Ornamenting Pottery. A. P. Morris, 90
Ortman, F. B.—Composition of Kiln Gases and their Effect on Terra-Cotta Glazes and Colours, 14
Orton: K. J. P., and G. W. Robinson.—Alumina, 2
"Osmo" Clay (Westerwald), 48
Ostwald, W.—Ceramic Chromatology, 89
Oven: Silica Bricks in Coke — Constructions. J. Enzenauer, 84
Ovens and Lehrs: Circular Flattening — — for Plate Glass, Bottles, etc. C. Baldermann, 108
— — Tanks: Grog Bricks, etc. for Building Glass — — J. Baldermann, 58
—: Coke —. American Coke and Chemical Co. and A. Roberts, 13
—: — —. Fours & Procédés Mathy Soc. Anon., 12
—: — W. E. Davies, 11
Owens Machine: Improved — — W. E. Evans, 111
Owens, M. J.—Gathering Molten Glass; Moulding under Pressure, 36

P

Paint: Impervious — C. H. Ivinson, 123
Parker, W. J.—see E. L. Warren, 122
Paschke, G.—Fuel Consumption; Calculation in Mixed Burnings, 18
Passow, H.—Blast Furnace Cement Goods, 118
Paton, J.—see Dowson & Mason Gas Plant Co., 69

Paving with Sand-lime Bricks. H. Jolig, 95
Pazsiezky, G.—Spun Glass, 113
Peaslee, W. D. A.—High Tension Insulator Porcelain, 100
Peat as Substitute for Coal, 84
— for Glass Industry. A. F. Wuromus, 18
—: Gasification of — in Generators with Horizontal Rotary Grates. M. Reiboldt, 18
Peculiar Phenomenon. G. Neuhaus, 44
— — K. Bernhard, 44
Peddle, C. J.—Development of Optical Glass during the War, 38
Peters, C. G. & C. H. Gragoe.—Measurements of the Thermal Dilatation of Glass at High Temperatures, 106
Petry, W.—Coal and Concrete, 40
Pfoff, A. and M. Donath.—Diagrammatic method of Calculating Ceramic Recipes, 61
Phenomenon: Peculiar — G. Neuhaus, 44
—: Peculiar — K. Bernhard, 44
Phillips, F. J.—Alkali Silicates, 127
Phonolite in Glass Manufacture, 33
Photography: Prime Colour Ceramic — C. Heck, 20
Phthisis in Lime Works. G. Hall, 45
Physical Properties of Porcelain. F. Singer and E. Rosenthal, 96
— Qualities of Materials: Testing — — R. Guillery, 24
Piece-work, 104
— System: Fate of — — in Bolshevik Russia, 103
Piesnack, P.—Brick Making Machines, 90
Pilkington Bros.—Grinding and Polishing Plate Glass, 113
Pipes: Centrifugal Machine for Cement — 119
—: Concrete — J. A. Glendinning, 121
—: Firing Stoneware — W. Schuen, 66
—: Impermeable Cement — 117
—: Moulding Cement — A. O. Crozier, 122
—: Salt-glazed Drain — 59
—: Stoneware — 59
—: Tunnels, etc., Reinforced Concrete — — G. C. Bartram, 122
Plaster Floors. M. Neuhaus, 42
— — for Granaries. B. Bosz, 42
— for Ventilating Shafts. R. Rüdinger, 41
—: Light — Bricks. Grosheim, 58
— Moulds: Utilization of Old — — E. Kirchheim, 98
— of Paris: Fire-proof Coatings of — — 39
Plastering v. Rough and Face Bricks for Building Purposes. G. Hamel, 40
Plastic Composition. L. Gauthier, 62
— —: Electric Insulation. E. F. A. Bultemann, 10
—: Rendering Non-plastic Material — A. Walter, 62
Platz.—Spa and the Brick Industry, 127
Platzmann, C.—Substitute for Cement, 120
Plauson, H.—Dispersoids, 127
— — — Colloid Powders, 126
Plowman, W.—see P. Schidrowitz, 51
Plugs: Sparking — 22
Polishing and Grinding Plate Glass. Pilkington Bros., 113
— Glassware. R. Haddan, 111
Porcelain and Glass: Electrical behaviour of — — at Moderately High Temperatures. R. F. Earhart, 94
—: Bodies for — Buttons, 9
—: Casting Heavy — Appliances for Electrical Purposes, 60
— Cement. Porzellanfabrik Kahla, 62
— Coins made at Meissen, 8
— Composition. General Electric Co., 10
—: Faulty Casting of — O. Rose, 11
— for Artificial Teeth, 9
—: Glost Oven — Colours. W. Funk, 90
—: High Tension Insulator — W. D. A. Peaslee, 100
— Industry: Problems of the — — F. Singer, 104
— Insulators. O. Boudouard, 100
—: Jews' — A. Kunth, 128
—: Method of Fixing in Hollow Cavities of — Objects by Shrinkage. H. Schomburg & Söhne, 61
— Physical Properties of — F. Singer and E. Rosenthal, 96
— Tubes: Prevention of Warping, 18
Porosity and Density of Fireclays. E. M. Firth, F. W. Hodkin, and W. E. S. Turner, 3
— — Volume Changes of Clay Fire Bricks at Furnace Temperatures. G. A. Loomis, 24
Portland Cement: Good — — K. Reinbold, 41
— —: Making — — R. W. Lesley, 123
— —: Rapid Method of Analysis of — — T. Klehe, 125
— —: Trass and — — G. Frede, 116
Porzellanfabrik Kahla.—Porcelain Cement 62
Potassium: Extraction of — from Felspar, 51
— Salts. Chemical Construction Co., 1
Pots: Casting — for Optical Glass. A. B. Taylor, 37
Potters' Wheel, 90

Pottery : Ancient Wendish — K. Strauss, 128
— Furnaces. J. R. C. August, 17
— Industry in 1919, 103
— Manufacture from Iowa Clays : Possibilities of — — W. G. Whitford and O. J. Whittemore, 4
— : Old Saxon — 128
— : — — Art — 128
— : — Silesian Art — K. Strauss, 44
— : Silesian and Saxon Lead-glaze — K. Strauss, 128
Powdered Fuel—see Fuel
Pratt, W. L.—Glass Furnaces, 107
Prehistoric Settlement : Discovery of — — 127
Presses : Brick — Etablissements Rouchard et Lamassiaude, 21
— : Eccentric — for Grog Bricks, 60
— : Extrusion — G. E. Neuberth, 21
— : Mechanical Efficiency of Brick — C. A. Kierling, 22
Pressing : Dry — K. Dümmler, 63
Press-moulding Machine. H. C. Daubenspeck and S. E. Winder, 113
Priest, C. F.—Continuous Gas-fired Kilns, 72
— — — Muffle-furnace, 73
Problems of the Porcelain Industry. F. Singer, 104
Producers : Gas — O. E. Yoe, 72
Profit-sharing. H. Göhring, 30
Prospecting for Clay. L. Schmelzer, 1
Protol, 50
Prototype : Hoffmann Kiln and its — K. Dümmler, 83
Prussian Buildings of Note. C. Sickel, 44
Pug-mills. E. Johnson, T. H. Gaskell and W. Boulton, Ltd., 92
Pukall, W.—Cause of Cracking and Scaling of Glazed Bricks, 88
Pullon, J. T.—Glass Blowing, 36
Pulverising Mill. Fuller-Lehigh Co., 93
— — : H. Cramm, 93
Pulverulent-fuel Furnaces : Feeding — — J. E. Muhfeld, 67
Purifier : Oil — 94
Pyrometer : Radiation — C. Zeiss, 74

Q

Quaternary Mixtures, 55

R

Radiation Pyrometer. C. Zeiss, 74
Ramming Machine for Cement Goods, 94
Rand, C. C.—Soda, Lime and Magnesia Content of Glass, type $RO.3SiO_2$, 33
Randolf—Bucket Conveyors, 22
Rare Earths : Their Nature and Uses. H. Sachse, 47
Raw Materials : Ceramic — — in France, 47
— — in Germany, 47
— — : Substitutes for Foreign — — in Germany. J. Klug, 1
Recipes : Diagrammatic Method of Calculating Ceramic — A. Pfoff and M. Donath, 61
Reeves, W. A.—see O. M. Tucker, 112
Refractories : Electric Furnace — A. F. Greaves-Walker, 48
— : — — 57
— : New — 62
— Under Load : Fireclay — A. S. Watts, 23
Refractory and Abrasive Composition. E. Assie, 10
— — Protective Coating on Furnace Linings. E. R. Stowell, 81
— Bond Clay. Dr. Seger and Cramer, 6
— Bricks : Behaviour of — — under Load at High Temperatures. K. Endell, 98
— — : Grading of — — O. Böndel, 96
— — : War Experiences with — — in the German Navy ; Standardisation. Schulz, 96
— Building Materials : Slag Attack on — — 30
— Crucibles, 61
— Industry in General : Development of — — H. Geyer, 102
— Lining for Cupola Furnaces. H. Geyer 82
— Material Manufactured in Turkey during the War. G. Bergua, 44
— — : Natural Sandstone as — — 47
— Materials : British Fireclays Suitable for Glass Furnace — — E. M. Firth, F. W. Hodkin, and W. E. S. Turner, 3
— — : Tensile Strength of — — M. W. Travers, 23
— — used in Chemical Industry. R. Kien, 47
— Mortars. E. Trab, 42
— Products : Grading of — — 95
— — Industry. J. Bied, 55
— — : Specific Heat and Heat Conductivity of — — 28
— Sillimanite Bricks : Malinite Process for Making — — H. Sachse, 58
— Substances. A. Rollason, 63
— — British Thomson-Houston & Co., 61
— — G. L. Dimitri, 61
— — L. Denis, 61
Regenerators. W. P. Thompson, 74
— : Clearing — 17

Regenerators : Furnace — A. B. Chantraine, 68
Regulating Air Supply and Draught of Furnaces. G. H. Gibson, 11
— Furnaces : E. McLean, 74
Regulations : Specimen of Works — 30
Reiboldt, R.—Gasification of Peat in Generators with Horizontal Rotary Grates, 18
Reinbold, K.—Good Portland Cement, 41
Re-inforced Concrete Ships, 40
Reitz, E.—Enamels and Glazes, 88
Renandin, A.—Electric Insulators, 63
Re-organisation of Brick Industry. J. F. Kleine, 31
Repair Work in the Combustion Chamber of Annular Kilns, 84
Resistant and non-actinic Paint for Cement. E. Blondel, 119
Retort Furnaces : Zinc Oxide. New Jersey Zinc Co., F. G. Breyer, and E. H. Bunce, 13
Retorts. J. E. Kennedy, 16
— : Gas — A. E. Whitcher, H. K. Hiller, and Hewitt Construction Syndicate, 12
— : Glazed — Prevention of Cracking, 62
— : Lining — and Furnaces. S. A. McMinn, 12
Reutlinger, E.—Heat Saving Investigations on Kilns, 70
— — Practical Economies in Firing Pottery, 70
Revermann, G. A.—Mechanical Stoker, 73
Richards, W. E.—Acid-proof Vessels, 60
Richardson, H.—Unloading Railway Vehicles, 91
W
Richter, F. Slip Glazes, 20
Rieke, R.—Utilisation of Waste Heat in Annular Kilns, 64
Riley, T. G.—Gaseous-fuel Furnace, 110
Rings of Concrete for Wells. R. Fabian, 42
Roach, J. H.—Stocking Apparatus, 68
Roberts, A.—see American Coke and Chemical Co., 13
Robertson, R. A.—see C. C. Millard, 10
Robinson, C. J.—Driving Potters' Lathes, 91
— G. W.—see K. J. P. Orton, 2
Rochette Frères.—Aluminates, 1
Rock Dust Collecting, 52
— : Separating Crushed — T. J. Sturtevant, 91
Rocks : Analysis of Silicate and Carbonate — W. F. Hillebrand, 42
— and Minerals : Colorimetric Tests for — — W. Zwieg, 42
Roder, H.—Mixing Cement with Coke Slack, 40
Roeder, W.—Cement in Water containing Sulphuric Acid, 41
Rohrwasser, F.—Economic Working of Porcelain Kilns, 17
Rollason, A.—Refractory Substances, 63
Roller-and-ring Mills. J. E. Kennedy, 91
— Track-conveyor for Bricks, 94
Rollers : Cement — 40
Roman Burnt-brick Structures. Hasak, 129
Rona, P., and P. György—Studies on Sedimentation, 54
Roofing : Cement — Tiles, 118
— Tiles, 60, 63
— — H. C. Badder, 96
— — J. G. Woodmans, 96
— — : Flat — — 8
— — : Manufacture of Cement — — 40
— — of Concrete. Kroher, 39
Roofs : Ferro-concrete Tile — 120
Roots, J. D.—Delivering Molten Metal, 114
Rose, O.—Faulty Casting of Porcelain, 11
Rosenthal, E.—see F. Singer, 96
Ross, C. J.—Moulding Slabs, etc., 121
Rotary Furnaces. F. Derneden, 75
— Grate. L. Tréfois, 69
— Kilns. H. Fenton and A. W. H. Vivian, 17
— — J. S. Fastings, 73
Rotating Muffle Furnace. J. R. C. August, 74
Röthke, O.—Future Constitution of Works' Management, 104
Roumanian Glass Industry, 31
— Stoves. K. Jacob, 18
Rücker, F.—"Berra"—a New Hollow Flooring Brick, 60
Rüdinger, R.—Plaster for Ventilating Shafts, 41
Rudisill, H. T.—Grinding Mill, 92
Russian Ceramic Industry, 128
Rusting of Iron in Ferro-concrete. H. Luftschitz, 40

S

Sachse, H.—Effect of Firing Period on the Vitrification of Clays, 66
— — Firing Temperatures Attainable with Wood, 82
— — — "Leukolith" A Mortar made from Anhydrite, 117
— — Malinite Process for making Refractory Sillimanite Bricks, 58
— — Rare Earths, 47
— — Trass as a Cement Saver, 117
Sadler, E.—Tea-pots, etc., 63
Saggar Clay Preparation, 9
Salt-glazed Drain Pipes, 59

Salts: Potassium — Chemical Construction Co., 1
Sand : Filter — G. Anklam, 1
— for Sand-Lime Bricks. B. Krieger, 1
— : Pure — 125
— Lime and Face Bricks : Bending Strain of — — 97
— — Bricks : Cheap Building Material, 40
— — : Cost Estimation of — — 105
— — : Impervious — — L. Gerber, 28
— — : Sand for — — B. Krieger, 1
— — used for Paving. H. Jolig, 95
— — — Industry : Lime and the — — B. Krieger, 102
— — works : Steam Meters for — — 93
— — — : The Neuss — — — B. Krieger, 58
Sandstone as Refractory Material, 47
Sasse—Influence of Mortar on Wall Strength, 117
Sauer, A.—Mechanical Appliances in Fine-ceramic Works, 90
— M.—Utilisation of Ashes from Porcelain and Earthenware Kilns, 64
Saxon Art Pottery, 128
— Clay and Kaolin Works, 44
— Pottery : Old — — 128
Scaling and Cracking of Glazed Bricks. W. Pukall, 88
Schidrowitz, P.—W. Feldenheimer and W. Plowman—Treating Clay, 51
Schlesische Spiegelglas-Manufaktur C. Tielsch.—Glass Manufacture, 109
Schmelzer, L.—Hollow Bricks, the Future Building Material, 8
— — Prospecting for Clay, 1
Schmidt, W.—Asbestos-cement Slabs, 39
Schmitt, L.—Undergrate Blowers, 66
Schoeber, B.—Hygiene of the Ceramic Industry, 129
Schöne, O.—Reconstruction of Grates for Firing with Lignite and Briquettes, 65
Schomburg H. & Söhne.—Method of Fixing Bodies by Shrinkage, 60
Schoenfelder, "Angle" Bricks, 60
— Brick Shape and Building Processes, 8
Schol, C. H.—Hardening Artificial Stone, 120
— — — Moulding Building-blocks, 60
Scholes, S. R.—Lining for Glass Pots, 35
Schonlau—Method of Applying Metallic Coatings to Artificial Stone, 119
School for Brickmakers at Frankfort-on-the-Oder, 128
— — Preparatory Training for Brick-makers, 127
Schools : Historical Notes on the Development of Brick-makers — 128
— E.—Heat Saving Arrangement of Revolving Tubular Kilns, 76
Schott, O.—Dust Determination in Flue Gases of Annular Kilns for Burning Portland Cement, 18
— O.—Steam-jet Blast or Under-grate Fans, 18
— — Works Managing in a Cement Factory, 103
Schott & Gen—Removing Bubbles from Molten Glass, 112
Schuen, W.—Firing Stoneware Pipes, 66
Schulz, H.—Measurement of Internal Forces by Optical Methods, 43
— War Experiences with Refractory Bricks in the German Navy; Standardisation, 96
Schwarz Machine : Hot Method of Preparing Sand-lime Brick Bodies. H. Jolig, 93
Schwazenbach, O.—Manufacture of Mother-of-Pearl Glass, 33
Scientific Work in the Ceramic Industry : Proper Appreciation and Remuneration of — — Koerner, 103
Scovill Manufacturing Co. and M. H. Bennett—Electrode Furnaces, 15
Screening and Conveying Apparatus. R. A. Hadfield, 93
— : Washing and — Plant for Gravel and Sand. Wetzel, 93
Sedimentation : Studies on — P. Rona & P. György, 54
Seger & Cramer—Refractory Bond Clay, 6
Sen, A. M.—Tests on the Air-slaking of Magnesia Calcined at Various Temperatures, 54
Separating Crushed Rock. T. J. Sturtevant, 91
Separator : Efficient Air — 22
Seydel, R.—Annular Kilns, 18
— — : Does it Pay to Improve Clays? 30
— — Firing Hoffmann Kilns, 17
— — Modern Open Air Drying Sheds, 20
— — What Happens during Firing? 66
Shaft Furnaces : Discharging — — F. W. Bakema, 75
Shales and Clays of Minnesota. F. F. Grout, 1
Sharratt, A.—Brick Kiln, 14
Shaw, J. B.—Fish Scaling, 20
— — — Open Hearth Furnaces, 67
Shearing Molten Metal. O. M. Tucker & W. Reeves, 112
Shipbuilding : Ferro-concrete — 39
Ships : Reinforced Concrete — 40
Shrinkage : Method of Fixing Bodies in Hollow Cavities of Porcelain Objects by — H. Schomburg & Söhne, 61
Sibson, W. W.—see T. Allsop, 64
Sickel, C.—Noteworthy Buildings of East and West Prussia, 44

Sickel, C.—Taylor System Applied to Bricklaying, 31
Sieber, W.—Bavarian Trass, 48
Sieg, Ch.—Value of Works Bookshop, 31
Sifter for Grinding-mills. E. E. Bentall, and G. C. Bingham, 93
Silesian & Saxon Lead-glaze Pottery. K. Strauss, 128
— Art Pottery: Studies in Old — — K. Strauss, 44
— Faience: Flourishing Period of — — 128
Silica Bricks: Action of Ferric Oxide on — — 28
— — in Coke-oven Construction. J. Enzenauer, 84
— Glass Industry. G. Flusin, 114
— Products. A. Bigot, 55
Silicate and Carbonate Rocks: Analysis of — W. F. Hillebrand, 42
Silicates: Alkali — F. J. Phillips, 127
Silicic Acid as a Medicine, 54
Sillimanite Bricks. Malinite Process for Making — — H. Sachse, 58
Singer, F.—Problems of the Porcelain Industry, 104
— — and E. Rosenthal. Physical Properties of Porcelain, 96
Slabs: Moulding — C. J. Ross, 121
Slag Attack on Refractory Building Materials, 30
— Cement. R. Boveroullé, 123
—: Casting — T. F. Hoare, 11
—: Treating — Norske Akt. Elektrokemisk Ind., 60
—: — — Norwegian Firm, 10
—: Utilization of — T. F. Hoare, 7
Slaked Lime and Milk of Lime. B. Kosmann, 53
Slaking Lime Mixed with Sand. W. Drakebusch, 58
Sleepers: Moulds for — F. J. Gey, 92
Slip Glazes. F. Richter, 20
Smeeth, W. F.—Cost of Burning Magnesite in Electrically Heated Kilns, 53
Smidth, F. L. & Co.—Concretes and Mortars, 38
Smith, Eng. Works—Gyratory Crushers, 91
— W.—Brick-cutting Machine, 91
— — Treating Clays, 60
Smoke and Dust: Report of a Commission on — — Question, 84
Smreker, O.—Concrete Beams, Sleepers, etc., 124
Soc. An. Verreries de Fauquez.—Glass Furnace, 112
— Anon. des Etablissements Ballot—Liquid Fuel Burners, 69
— C. Boucher et Fils—Glass Furnaces, 37
Soc. An. d'Utilisation des Combustibles Liquids.—Oil Burner for Furnaces, 73
— Française de Travaux et Const. de Fours—Gas Producer, 66
— Le Basalte—Moulding Machine, 92
— — — Moulds, 92
Soda Composition. L. Springer, 32
— Lime, and Magnesia Content of Glass Type $RO.3SiO_2$—C. C. Rand, 33
— magnesia Glasses: Density of — — S. English and W. E. S. Turner, 37
Sodium Sulphate: Use of Specially Purified — — for making A1 Crystal Glass. K. Killer, 34
Sommerville, W.—Lime Kilns, 73
Son Schlyter—Testing Swedish Bricks, 42
Spa and the Brick Industry. Platz, 127
Sparking Plugs, 22
Specific Heat of Refractory Products, 28
Sperber, F.—Eight-hour Day in the Ceramic Industry, 105
Spray Burners. Westf. Gasglühlicht-Fabrik and G. Killing, 68
Spraying: Mortar — Machines, 119
— Process for Concrete and Mortar, 40
Springer, L.—Calculation of Hardness or Expansion of Glass, 34
— — Soda Composition, 32
— — Sulphate-waterglass Mixtures as Substitutes for Alkalis in Glass Batch, 38
Sproat, J. E., and D. Allbright—Dressler Tunnel Kiln, 14
Syrian Ceramic Art. G. Badermann, 44
Standard Stove, 88
Standardisation in Building Industry. K. Matthies, 31
— of Concrete Stonework for Balustrades. A. Friesecke, 38
— — Refractory Bricks: War Experiences in the German Navy. Schulz, 96
Stanfield, G.—see F. C. Fairholme, 24
Stansfield, H.—Blast Apparatus for Furnaces, 68
Statistics: Manufacturing — 30
Steam Boilers: Liquid Fuel for — — Ingold, 81
— Jet Blast or Under-grate Fans. O. Schott, 18
— — — L. Friedlander, 18
— — — Blasts, 76
— Meters for Sand-lime Brick Works, 93
Steel Belt Conveyors, 94
Stein & Atkinson—see J. S. Atkinson, 36
— see D. M. Cunningham, 17
Steinke, P. J.—Testing Hardness of Materials, 96
Stephenson, J.—Moulding Building-Blocks, 91

Stoker for Furnace. J. Y. Johnson, 72
— : Mechanical — G. A. Revermann, 73
— : Underfeed — Underfeed Stoker Co., 66
Stoking Apparatus. J. H. Roach, 68
—: Mechanical — — W. E. Demil and W. M. McRobert, 73
Stone : Artificial — J. Ward, 121
— : — — P. B. Crossley, 114
— : — — White Heat Products Co., 9
— : Hardening Artificial — C. H. Schol, 120
— Slabs : Artificial — — for Railway Crossings, 39
Stoneware : Acid-proot — E. Wilde, 9
— : Clay or — Utensils for Poultry Farms. A. Wulf, 60
— Floor Tiles : Preparation of Bodies for — — — E. Tuschhoff, 62
—: Hard — body for Electric Insulators, 62
— Pipes, 59
— — : Firing — — W. Schuen, 66
— : Utilization of — 103
Stove : Standard — 88
Stoves : Roumanian — K. Jacob, 18
Stowell, E. R.—Refractory and Protective Coating on Furnace Linings, 81
Strauss, K.—Ancient Wendish Pottery, 128
— — Lead Glaze Pottery in Silesia and Saxony, 128
— — Studies in Old Silesian Art-pottery, 44
Street Paving with Sand-lime Bricks. H. Jolig, 95
Strehl, J.—Clay and Marl Excavators, 102
Sturtevant, T. J.—Separating Crushed Rock, 91
Substitutes for Foreign Raw Materials in Germany. J. Llug, 1
Sulphate-waterglass Mixtures as Substitutes for Alkalis in Glass Batch. L. Springer, 38
Sulphur : Recovery of — from Gypsum. L. Martin, 124
Sulphuric Acid : Cement in Water containing — — W. Roeder, 41
Surface Friction : New Facts about — — C. Terzaghi, 53
— Leakage as a Factor in Insulator Design. T. M. Fedor, 101
Swally, E. L.—Electric Furnaces, 70
Swedish Bricks : Testing — — Son Schlyter, 42
Swinburne, J.—Low Temperature Coking, 12

T

Taque, G. O.—Automatic Bottle-blowing Machine, 113
Tar-oil instead of Coal. A. Schmid, 18
Taylor, A. B.—Casting Pots for Optical Glass, 37
— System : O. J. Gérin, 103
— — and the Brick Industry. Grüneisen 31
— — Applied to Brick Transport, 104
— — — to Bricklaying. G. Sickel, 31
Tea-cup Handles : Moulding — — W. H. Edwards & Edwards & Sons, 64
Teale, J. W.—Discharging Device for Lime Kilns, etc., 72
Tea-pots, etc. E. Sadler, 63
— Coffee-pots, etc. W. H. Mitchell, 63
Tedeschi, V.—Electric Insulators, 8
Teeth : Porcelain for Artificial — 9
Teichmann, K.—Application of Generator Gas-firing to Ceramic Industry, 70
Teisen, T.—Tunnel Kilns, 68
Temperature : Measurements of Thermal Dilation of Glass at High — C. G. Peters and C. H. Gragoe, 106
Temperatures : Behaviour of Refractory Bricks under Load at High — K. Endell, 98
— : Electrical Behaviour of Porcelain and Glass at Moderately High — R. F. Earhart, 94
— : Firing — attainable with Wood. H. Sachse, 82
— : Porosity and Volume Changes of Clay Fire Bricks at Furnace — G. A. Loomis, 24
Templeton, S.—Excavators, 91
Tensile Strength of Refractory Materials. M. W. Travers, 23
Terneden, J. L. and P. J. Kummel—Gas Manufacture, 17
Terra-cotta Glazes and Colours : Composition of Kiln Gases and Effect on — — F. B. Ortman, 14
Terzaghi, C.—New Facts about Surface Friction, 53
Testing Hardness : Machine for — — W. & T. Avery and H. N. Cox, 24
— — of Materials. F. C. Fairholme, W. H. Hatfield, and G. Stanfield, 24.
— — — L. Johnson and H. Brearley, 24
— — —. P. J. Steinke, 96
— Oils and Lubricants, 126
— Materials, 98
— Physical Qualities of Materials. R. Guillery, 24
— Swedish Bricks. Son Schlyter, 42
Tests : Colorimetric — for Minerals and Rocks. W. Zwieg, 42
— on the Air-slaking of Magnesia Calcined at Various Temperatures. A. M. Sen, 54

Thermal "Balance-sheet" of an Annular Kiln. R. Claus, 66
— Dilatation of Glass : Measurements of — — C. G. Peters and C. H. Gragoe, 106
Thermo-Technical Advice Bureau for the German Glass Industry, 128
Thomas, G. C.—Moulding Bricks, Blocks, etc., 92
Thomeley, E. W.—Concrete Chimney Flues, 121
Thompson, H. M.—Annealing Furnaces, 36
— W. P.—Regenerators, 74
Thor, P.—Coal Saving Method of Firing Annular Kilns, 82
Tile : Fero-concrete — Roofs, 120
Tiles : Cement Roofing — 40, 118
— : Clays for — 48
— : Concrete Roofing — Kroher, 39
— : Danish Machine for Making Cement — 39
— : "Deva" Flooring — 62
— : Flat Roofing — 8
— from Clays containing Lime. H. Jordt, 9
— : Gypsum Moulds for Interlocking — Baschant, 60
— : Moulding — A. Muller Bauten and Industriewerke, 22
— : Negligence in use of Wall — of best Quality. H. Dollinger, 32
— : New Roofing — 60
— : Preparation of Bodies for Stoneware Floor — E. Tuschhoff, 62
— : Roofing — 63
— : — — H. C. Badder, 96
— : — — J. G. Woodimann, 96
— : Waterproof Cement — 39
— : White Glazed Face — Hasak, 88
Todd, W. J.—Brick Machines, 90
Tombstones, etc : Ceramics for — J. Lerg, 44
Tooley, G. W.—see R. and J. Dempster, 15
Trab, E.—Refractory Mortars, 42
Trade Combines. C. Cirkel, 102
— Unions and Works' Councils. B. Juster, 104
Transition Points : Study of — — by a Dilatometric Method. P. Braesco, 52
Trass and Portland Cement. C. Fredl, 116
— as a Cement Saver. H. Sachse, 117
— : Bavarian — Gebauer, 4
— : — — W. Sieber, 48
Travers, M. W.—New Type of Gas-fired Furnaces, 38
— — — Tensile Strength of Refractory Materials, 23
Trairs, W.—see T. H. Watson & Co., 12
Tréfois, L.—Rotary Grate, 69
Tubes : Porcelain —, Prevention of Warping, 18
Tubing : Discoloration in Lampworked Glass — F. W. Hodkin and W. E. S Turner, 37
Tucker, E.—Concrete Blocks as Substitutes for Bricks, 39
— O. M. and W. Reeves.—Shearing Molten Metal, 112
— — — and J. M. Beatty.—Delivering Molten Metal, 112
Tuhten, F. C. A.—Decorating Pottery, 89
Tunnel Brick-driers. T. Entwistle, 64
— Furnaces. D. M. Cunningham and Stein & Atkinson, 17
— Kilns, see Kilns
Turkish Refractory Materials during the War. G. Bergau, 44
Turner, W. E. S.—see E. M. Firth, 3
— — — — see F. W. Hodkin, 37
— — — — see S. English, 37
Tuschhoff, E.—Cooking Utensils, 60
— — Flower Pots, 64
— — Preparation of Bodies for Stoneware Floor Tiles, 62
Twigg, F. J.—see H. A. Hamilton, 124

U

Ueda, T.—Frosted Glass, 109
Under Load : Behaviour of Refractory Bricks — — at High Temperatures. K. Endell, 98
Unloading Railway Vehicles. H. Richardson, 91
Ultramarine : Behaviour of — in Cement. K. Haerting, 118
Utilization of Ashes from Porcelain and Earthenware Kilns. M. Sauer, 64
— — Waste Heat in Annular Kilns. R. Rieke, 64
Unburned Bricks. Hirsch, 7
Underfeed Stoker Co.—Underfeed Stoker, 66
Undergrate Blower : New — — 88
— Blowers. L. Friedlander, 66
— — L. Schmitt, 66
— Fans or Steam-jet Blast. O. Schott, 18
— — *v.* Steam-jet Blast. O. Schott, 18

V

Valuation of Clay Deposits, 103
Ventilating Shafts : Plaster for — — R. Rüdinger, 41
Vickers, Ltd. and G. T. Buckham.—Concrete Moulding Machine, 123
Vitreosil Gas-Mantle Protectors, 108
Vitrification of Clays : Effect of Firing Period on — H. Sachse, 66

Virginia Plate Glass Corporation, and A. A. Icenhour.—Glass Drawing, 35
Volatilization of Iron Oxide in Enamels, Influence of Metallic Chorides, 19
Volume Changes of Clay Firebricks at Furnace Temperatures. G. A. Loomis, 24
Vivian, A. W. H.—see H. Fenton, 17
Vickers, Ltd. and N. E. Dufty—Moulding by Centrifugal Force, 21

W

Wachwitz, K.—Care of Machinery, 22
Wade, H.—Carboys, etc., 111, 114
— — Zirconium, Salts, 51
Wages Question in the Brick Industry. A. Milde, 102
Waite, H. S.—see D. F. Campbell, 67
Wakefield, J. L.—Jollies, 91
Walker, T.—see C. E. Holt, 15
Wallace, J.—Moulds, 92
Walter, A.—Rendering Non-plastic Materials Plastic, 62
Ward, J.—Artificial Stone, 121
Ware : Läuger — J. Lerg, 44
Warga, K.—Coloured Glass, 112
Warren, E. L. and W. J. Barker.—Moulding Concrete Blocks, etc., 122
Washing and Screening Plant for Gravel and Sand. Wetzel, 93
Waterglass : Sulphate — Mixtures as Substitute for Alkalis in Glass Batch. L. Springer, 38
Waterproof Cement Tiles, 39
Watson, T. H. & Co., H. A. Greaves and H. Etchells and W. Travis—Electrode Furnaces, 12
Watts, A. S.—Fireclay Refractories under Load, 23
Weber & Co. Excavating Clay, 51
Weigers, A. W. F.—Brick Kilns, 68
Wellington, J. M. and Mackenzie D. G.—Moulding Concrete Blocks, 123
Wellman Smith Owen Eng. Corporation and A. V. Kemp.—Furnace Values, 67
Welte, H.—Metal Coatings, 7
Wilzin Autom. Bottle-blowing Mach. Co. —Bottle-blowing Machine, 112, 113
Wendish Pottery : Ancient — — 128
Wendler, K.—Establishing the Output of Brickworks, 32
West, J.—Conveyors, 93
— T.—Brick Kilns, 72
Westf. Gasglühlicht-Fabrik and G. Killing—Spray Burners, 68
Wetzel.—Washing and Screening Plant for Gravel and Sand, 93
Wheel : Potter's — 90
White, A. E.—Crucible Furnace, 68
— Glazed Face-tiles. Hasak, 88
White Heat Products Co.—Artificial Stone, 9
Whitcher, A. E., H. K. Hiller, and Hewitt Construction Syndicate.—Gas Retorts 12
Whitfield, C.—Tunnel Kiln, 72
Whitford, W. G. and O. J. Whittemore.—Possibilities of Pottery Manufacture from Iowa Clays, 4
Wilcox Machine Co.—Glass Manufacture, 112
Wilkins, H.—Glass Furnace, 110
Wille, E.—Acid-proof Stoneware, 9
Williams, A. D.—Open Hearth Furnaces, 76
— C. R.—Concrete Moulding, 123
Willner, S.—see W. Dederich, 69
Wilson, W.—Concrete Blocks and Slabs, 124
Winder, S. E.—Bottle-blowing Machines 114
— — — see H. C. Daubenspeck, 112, 113
Winkler, K.—Waterproofing Concrete, 122
Wolf, J.—Delivering Glass Furnaces, 112
Wood : Firing Temperatures Attainable with — H. Sachse, 82
— from Tree-stumps used for Kiln Firing, 11
Woodman, J. G.—Roofing Tiles, 96
Work :—Indicating Progress of — Mann, Egerton & Co., 106
Works' Councils and Trade Unions. B. Juster, 104
Works Book-shop : Value of — — Ch. Sieg, 31
— Management : Future Constitution of — O. Röthke, 104
— — in a Cement Factory. O. Schott, 103
— Regulations: Specimen, 30
Wulf, A.—Clay or Stoneware Utensils for Poultry Farms, 60
Wuromus, A. F.—Peat for Glass Industry, 18

Y

Yamaguchi, K.—Concrete Walls, 121
Yeo, O. E.—Gas Producers, 72
Young, A.—Moulding Concrete Blocks, 124

Z

Zehner's "Reform" Kiln for Small Works, 84
Zeiss, C.—Glass Cutting, 114
— — Radiation Pyrometer, 74
Zetzsche, C.—Hamburg Buildings, 127
Zigzag Kilns, 76

Zinc : Effect of — in Forms of Various Compounds for a Chrome-green Glaze, 19
— : Electrode Furnaces for — Norwegian Firm, 13
— Oxide : Lead Sulphate ; Furnaces. W. J. Fadden, 16
— —: Retort Furnaces. New Jersey Zinc Co., F. G. Breyer, and E. H. Bunce, 13
Zirconia : Preparation of — 49
Zirconium. W. North and H. Loosli, 51
— Salts. H. Wade, 51
Zubiria, J. R.—Electrode and Induction Furnaces, 68
Zwermann, C. H.—Tunnel Kilns, 16
Zwieg, W.—Colorimetric Tests for Minerals and Rocks, 42

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